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Full document details: 20/30424653 DC

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



62C/778/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER: IEC 61217 ED3	
DATE OF CIRCULATION: 2020-08-07	CLOSING DATE FOR COMMENTS: 2020-10-30
SUPERSEDES DOCUMENTS: 62C/768/RR	

IEC SC 62C : EQUIPMENT FOR RADIOTHERAPY, NUCLEAR MEDICINE AND RADIATION DOSIMETRY	
SECRETARIAT: Germany	SECRETARY: Mr Norbert Bischof
OF INTEREST TO THE FOLLOWING COMMITTEES: SC 62B	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☒ SAFETY	

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TITLE:

Radiotherapy equipment - Coordinates, movements and scales

NOTE FROM TC/SC OFFICERS:

The document has been drafted by WG 1.

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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 62 C: Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC technical committee 62: Electrical equipment in medical practice.

This third edition cancels and replaces the second edition, published in 2011.

This edition includes the following significant technical changes with respect to the previous edition:

- a) This edition constitutes a technical revision to include non-isocentric and non-gantry-based treatment equipment, positioners with six degrees of freedom, and imaging systems used for treatment simulation and for image-guided radiotherapy.
- b) This edition attempts to simplify the organization and hierarchy of coordinate and scale systems by reducing the number of individual components for which coordinate systems are defined.
- c) Finally, this edition makes recommendations for transformation matrices and procedures for implementing coordinate transformations to avoid ambiguity and error.;

The text of this International Standard is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

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

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

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

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

The National Committees are requested to note that for this document the stability date is **2026**. <please comment, to be frozen at CDV stage>

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

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 EQUIPMENT 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 of 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, COMPUTED TOMOGRAPHY (CT), POSITRON-EMISSION TOMOGRAPHY (PET) and MAGNETIC RESONANCE imaging (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 occur when using different types of ME EQUIPMENT. Hence, its scope applies to all types of TELERADIOTHERAPY ME EQUIPMENT; BRACHYTHERAPY ME EQUIPMENT; RADIOTHERAPY SIMULATORS; information from diagnostic ME EQUIPMENT when used for RADIOTHERAPY; TREATMENT management systems including recording and verification equipment and software; and to data handled during the TREATMENT PLANNING process.

One important benefit of a standard coordinate system is its contribution to safety in RADIOTHERAPY TREATMENT PLANNING. The scales that are recommended by 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.

Movement nomenclature is classified as defined terms according to IEC/TR 60788:2004 as are terms defined in IEC 60601-2-1, IEC 60601-2-8, IEC 60601-2-11, IEC 60601-2-17, IEC 60601-2-29, IEC 60601-2-64, and IEC 60601-2-68 (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 requirements stated here will not appear in future editions of the IEC 60601-2 series, which deals exclusively with safety requirements.

IEC 60601-2-1, IEC 60601-2-8, IEC 60601-2-11, IEC 60601-2-17, IEC 60601-2-29, IEC 60601-2-64, IEC 60601-2-68, IEC 60976, IEC 60977, IEC 61168, IEC 61170, IEC 62667 and IEC 62926 include ME EQUIPMENT movements and scale conventions. A number of changes and additions have been made in this standard and therefore those changes will be reflected in all standards that refer to ME EQUIPMENT movements and scales.

Amendment 2 to the 1st edition, published in 2007, extended the description of rotation of the PATIENT support devices around the Z-axis in the IEC fixed coordinate system (known in engineering terms as “yaw”) to two additional rotations – rotation around the PATIENT’S longitudinal axis (“roll”) and rotation around the patient’s transverse axis (“pitch”).

The use of the two new additional degrees of freedom (pitch and roll) generalises the coordinate systems to include 3 rotations and 3 translations, thereby supporting 6 degrees of freedom in a systematic fashion. This system of 6 degrees of freedom is employed by the 3rd edition of this standard for all components of radiotherapy equipment, including the patient support system and the patient. The terms pitch, roll and yaw are used extensively in this standard.

change is a significant departure from the previous editions of this standard, use of these terms could simplify descriptions of equipment movements, especially in cases where no commonly-accepted term exists. Where an accepted term does exist (e.g., gantry rotation) and applies appropriately, the term is acknowledged as a preferred alternative to the proposed term (e.g., roll).

NOTE Some radiotherapy equipment uses a fixed beam direction and positions the patient relative to the beam using a treatment chair or a multi-axis positioner. The proposed coordinate system and terminology apply equally well in this situation.

In this version of the standard, the reliance of the reference coordinate system on an equipment ISOCENTRE has been removed. Instead, the EQUIPMENT REFERENCE COORDINATE SYSTEM is now defined as having its origin at the EQUIPMENT REFERENCE POINT (ERP). In the case of ISOCENTRIC equipment, the ERP is the equipment ISOCENTER, and the EQUIPMENT REFERENCE COORDINATE SYSTEM is equivalent to the “fixed” system defined in Ed. 2 of this standard.

Manufacturers also can define a PATIENT SETUP REFERENCE POINT. This point is related to the ERP and, where the equipment design requires it, can be used to position the patient in preparation for shifting the patient to the ERP.

To facilitate application of this standard to a wide variety of equipment designs, the hierarchy of the various coordinate systems has been simplified.

RADIOTHERAPY EQUIPMENT – COORDINATES, MOVEMENTS AND SCALES

1 Scope

This International Standard applies to equipment and data related to the process of RADIOTHERAPY, including ELECTRON ACCELERATORS, LIGHT-ION BEAM MEDICAL ELECTRICAL EQUIPMENT, GAMMA BEAM THERAPY EQUIPMENT, X-RAY RADIOTHERAPY EQUIPMENT, REMOTE AFTERLOADING BRACHYTHERAPY EQUIPMENT, RADIOTHERAPY SIMULATORS, EQUIPMENT for IMAGE-GUIDED RADIOTHERAPY, and PATIENT image data used with RADIOTHERAPY TREATMENT PLANNING SYSTEMS.

The object of this standard is to define a consistent set of coordinate systems for use throughout the process of RADIOTHERAPY, 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60601-2-1:2009, *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 60601-2-8: *Medical electrical equipment – Part 2-8: Particular requirements for basic safety and essential performance of therapeutic X-ray equipment operating in the range 10 kV to 1 MV*

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

IEC 60601-2-17: *Medical electrical equipment – Part 2-17: Particular requirements for basic safety and essential performance of automatically-controlled brachytherapy afterloading 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 60601-2-64: *Medical electrical equipment – Part 2-64: Particular requirements for the basic safety and essential performance of light ion beam me equipment*

IEC 60601-2-68 *Medical electrical equipment – Part 2-68: Particular requirements for basic safety and essential performance of X-ray based image guided radiotherapy with electron accelerators*

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*

IEC 60976, Medical electron accelerators – Functional performance characteristics

IEC 60977, Medical electron accelerators – Guidelines for functional performance characteristics

IEC 61168, Radiotherapy simulators – Functional performance characteristics

IEC 61170, Radiotherapy simulators – Guidelines for functional performance characteristics

IEC 62667: Medical electrical equipment - Medical light ion beam equipment - Performance characteristics

IEC 62274: Medical electrical equipment – Safety of radiotherapy record and verify systems

IEC 62926: Medical electrical system - Guidelines for safe integration and operation of adaptive external-beam radiotherapy systems for real-time adaptive radiotherapy

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardisation at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

EQUIPMENT REFERENCE AXES

coordinate axes defined in the EQUIPMENT REFERENCE COORDINATE SYSTEM

3.2

EQUIPMENT REFERENCE COORDINATE SYSTEM

ERCS

cartesian right-handed coordinate system with its origin at the ERP, the X axis horizontal and to the patient's left, and the Z axis vertically upward when all coordinate system angles are set to zero

Note 1 to entry: The EQUIPMENT REFERENCE COORDINATE SYSTEM is identical to the fixed reference system in IEC 61217.

3.3

EQUIPMENT REFERENCE POINT

ERP

point in space that serves as the origin of the EQUIPMENT REFERENCE COORDINATE SYSTEM and as the fundamental reference of descendent coordinate systems.

Note 1 to entry: Typically the EQUIPMENT REFERENCE POINT is coincident with the ISOCENTRE. If the beam delivery equipment is not ISOCENTRIC, then the centre of the PATIENT alignment system may be used.

Note 2 to entry: This note applies to the French text only.

[SOURCE: IEC 60601-2-1:2019, 201.3.220.]

3.4**EXTRINSIC**

<rotation angle> a rotation of a coordinate system around an axis of its parent or “mother” system (the immediately-superior coordinate system in the hierarchy)

3.5**INTRINSIC**

<rotation angle> a rotation of a coordinate system around an axis of its own system

3.6**LIGHT ION REFERENCE AXIS**

<LIGHT ION BEAM> the line in the REFERENCE DIRECTION through the centre of the LIGHT ION VIRTUAL SOURCE

Note 1 to entry: For photon and electron beams, see REFERENCE AXIS.

[SOURCE: IEC 62667.]

3.7**PATIENT POSITIONER**

<RADIOTHERAPY> assembly of equipment upon which the PATIENT is placed and positioned for RADIOTHERAPY

Note 1 to entry: The PATIENT POSITIONER includes the TABLE TOP and TABLE TOP SUPPORT.

[SOURCE: IEC 60601-2-1 Ed. 4.]

3.8**PATIENT SETUP REFERENCE POINT**

a point defined in the ERCS with a fixed relationship to the ERP, that can be used to position the patient in preparation for shifting the patient to the treatment position.

3.9**PITCH**

rotation around an equipment's X axis.

3.10**REFERENCE AXIS**

line through the centre of a RADIATION SOURCE in the direction perpendicular to the plane of either the front surface of the TARGET if X-RADIATION, or the ELECTRON RADIATION window if ELECTRON RADIATION

Note 1 to entry: For LIGHT ION BEAMS, see LIGHT ION REFERENCE AXIS.

3.11**REFERENCE CONDITIONS**

conditions under which all influence quantities and instrument parameters have their reference values

Note 1 to entry: See clause 7 for a description of reference values.

3.12**REFERENCE DIRECTION**

specified direction to which characteristics such as target angle, radiation field and specifications with respect to the imaging quality of the radiation source are referenced

[SOURCE: IEC 61267.]

3.13**REFERENCE TREATMENT DISTANCE****RTD**

<ELECTRON RADIATION> SPECIFIED distance measured along the REFERENCE AXIS from the ELECTRON RADIATION window to the distal end of the ELECTRON BEAM APPLICATOR or to a SPECIFIED plane containing the EQUIPMENT REFERENCE POINT

<X-RADIATION> SPECIFIED distance measured along the REFERENCE AXIS from the TARGET surface of the exiting beam to a SPECIFIED plane containing the EQUIPMENT REFERENCE POINT

Note 1 to entry: The REFERENCE TREATMENT DISTANCE replaces the use of NORMAL TREATMENT DISTANCE in previous editions of IEC 60601-2-1.

3.14**REFERENCE TREATMENT PLANE****RTP**

plane containing the EQUIPMENT REFERENCE POINT and which is perpendicular to the therapeutic REFERENCE AXIS

3.15**Roll**

rotation around an equipment's Y axis.

3.16**VIRTUAL SOURCE (from IEC 60788)**

point from which the radiation appears to originate

Note 1 to entry: In scanning techniques the 2 axes of scanning might have a different virtual source position.

[SOURCE: IEC 60788.]

3.17**Yaw**

rotation around an equipment's Z axis.

4 Coordinate systems**4.1 General**

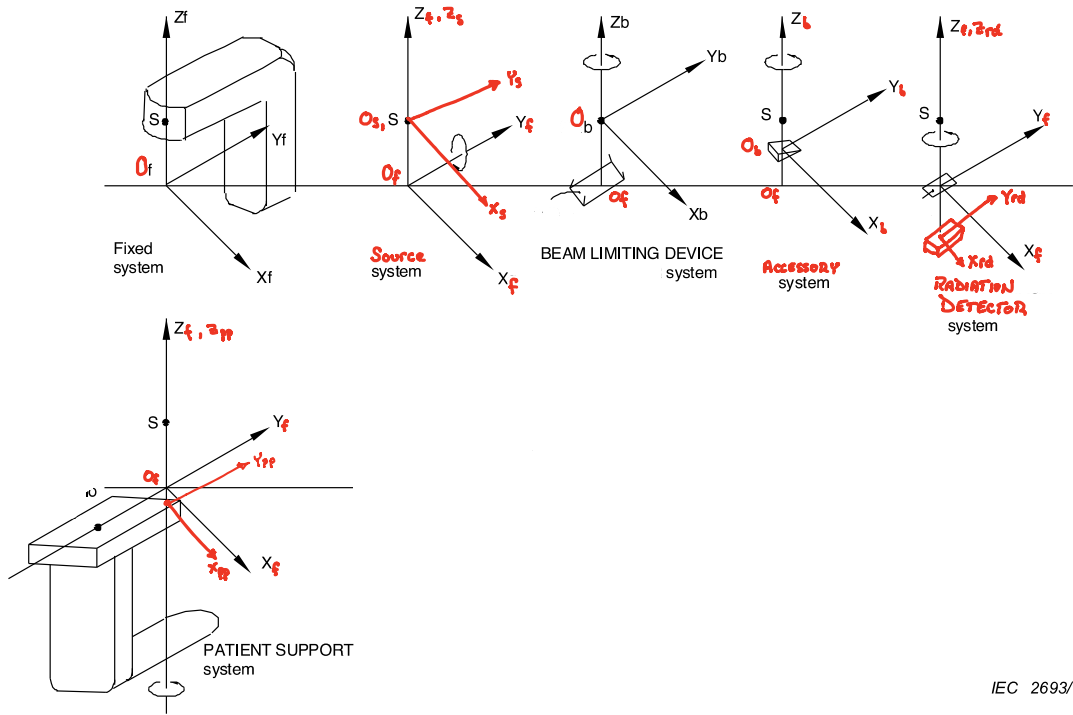
An individual coordinate system is assigned to each major part of the ME EQUIPMENT which can potentially be moved in relation to another part, as illustrated in Figure 1a and summarised in Table 1. Furthermore, an EQUIPMENT REFERENCE COORDINATE SYSTEM (ERCS) is defined. The origin of the ERCS is the EQUIPMENT REFERENCE POINT (ERP). For ISOCENTRIC EQUIPMENT, the ERP is normally the ISOCENTRE. Each major EQUIPMENT part (e.g. SOURCE, PATIENT POSITIONER) is always stationary with respect to its own coordinate system.

Perspective views of ISOCENTRIC and non-ISOCENTRIC medical ELECTRON ACCELERATORS are shown in Figures 1a, 6, and 7. Isometric projection drawings of coordinate systems are shown in Figures 1a, 6, and 7. 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.

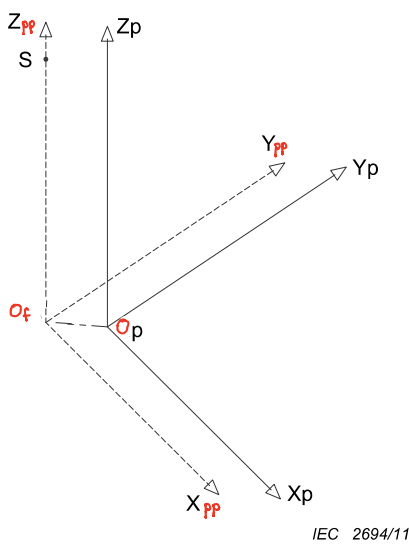
The definitions of coordinate systems, as stated in the following subclauses, allow mathematical transformations (rotation or translation) of the coordinates from one system to any other coordinate system. See Annex A for a description of the method and examples of coordinate transformations.

Reviewers please note that most of the diagrams have been marked up by hand to enable discussion. Once decisions are made about the major issues regarding this document, better diagrams will be prepared.



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- S = RADIATION SOURCE
- Io = ISOCENTRE
- R/D F = RADIATION FIELD or DELINEATED RADIATION FIELD
- IR = X-RAY IMAGE RECEPTOR



IEC 2694/11

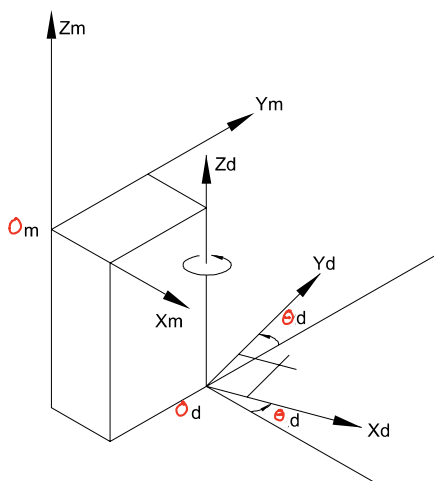
PATIENT coordinate system

- S = RADIATION SOURCE
- Of = ERP

475 RF = RADIATION FIELD

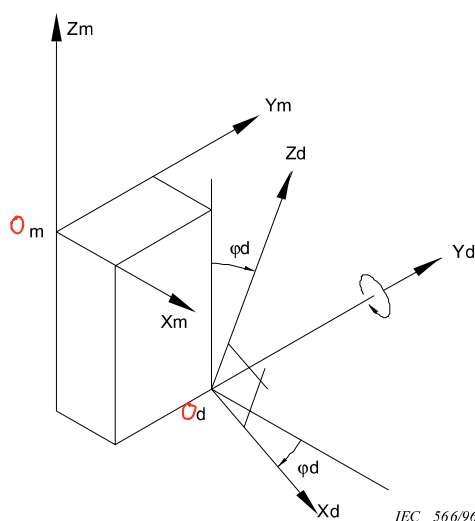
476 RD = RADIATION DETECTOR

477 **Figure 1a – Coordinate systems for a RADIOTHERAPY EQUIPMENT**
 478 **(see 4.1) with all angular positions set to zero**



IEC 563/96

479
 480 **Figure 1b – Rotation (YAW) of daughter system about axis Z_d followed by extrinsic**
 481 **translation of origin O_d of daughter system from the origin O_m and along axes X_m, Y_m,**
 482 **Z_m of mother system (see 4.2f)).**



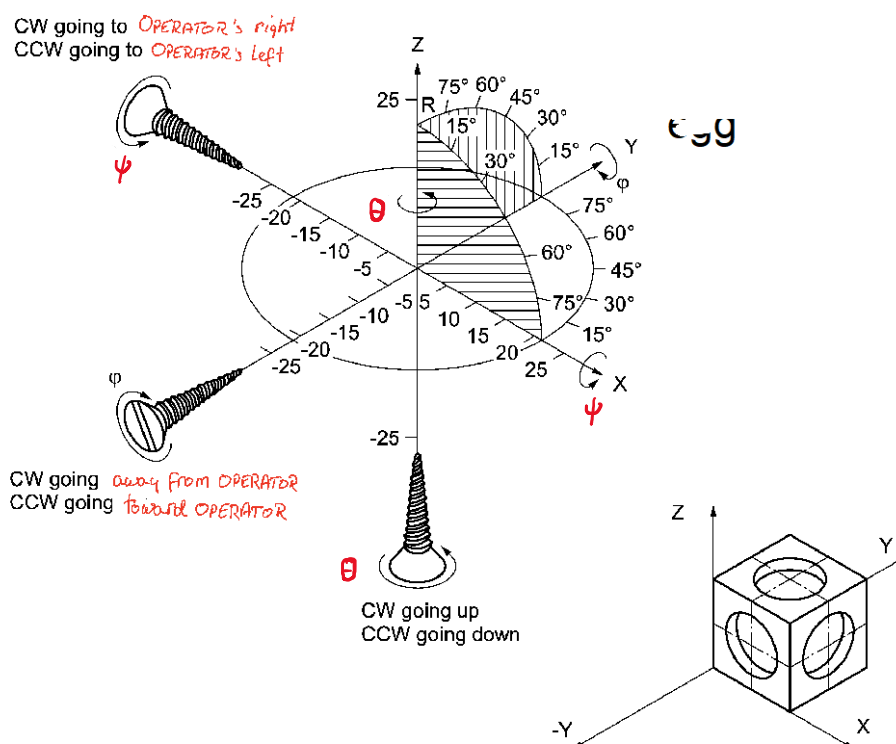
IEC 566/96

483
 484 **Figure 1c – Translation of origin O_d of the daughter system from the origin O_m and**
 485 **along axes X_m, Y_m, Z_m of the mother system, followed by intrinsic**
 486 **rotation (ROLL) of the daughter system around axis Y_d (see 4.2 d)).**

4.2 General Rules

The following requirements apply:

- 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.
- When the perspective of an OPERATOR or USER is described, the term “OPERATOR” is used. The position of the “OPERATOR” is considered to be at the negative end of the Y axis of the ERCS. For conventional gantry-mounted ISOCENTRIC equipment, this would be at the foot of the PATIENT POSITIONER, facing the GANTRY.
- Where the expression “facing along axis _” is used, the intent is that the OPERATOR is standing at the negative end of the axis, looking toward the positive end.



865

ψ = Pitch, or rotation of Y and Z around X

ϕ = Roll, or rotation of Z and X around Y

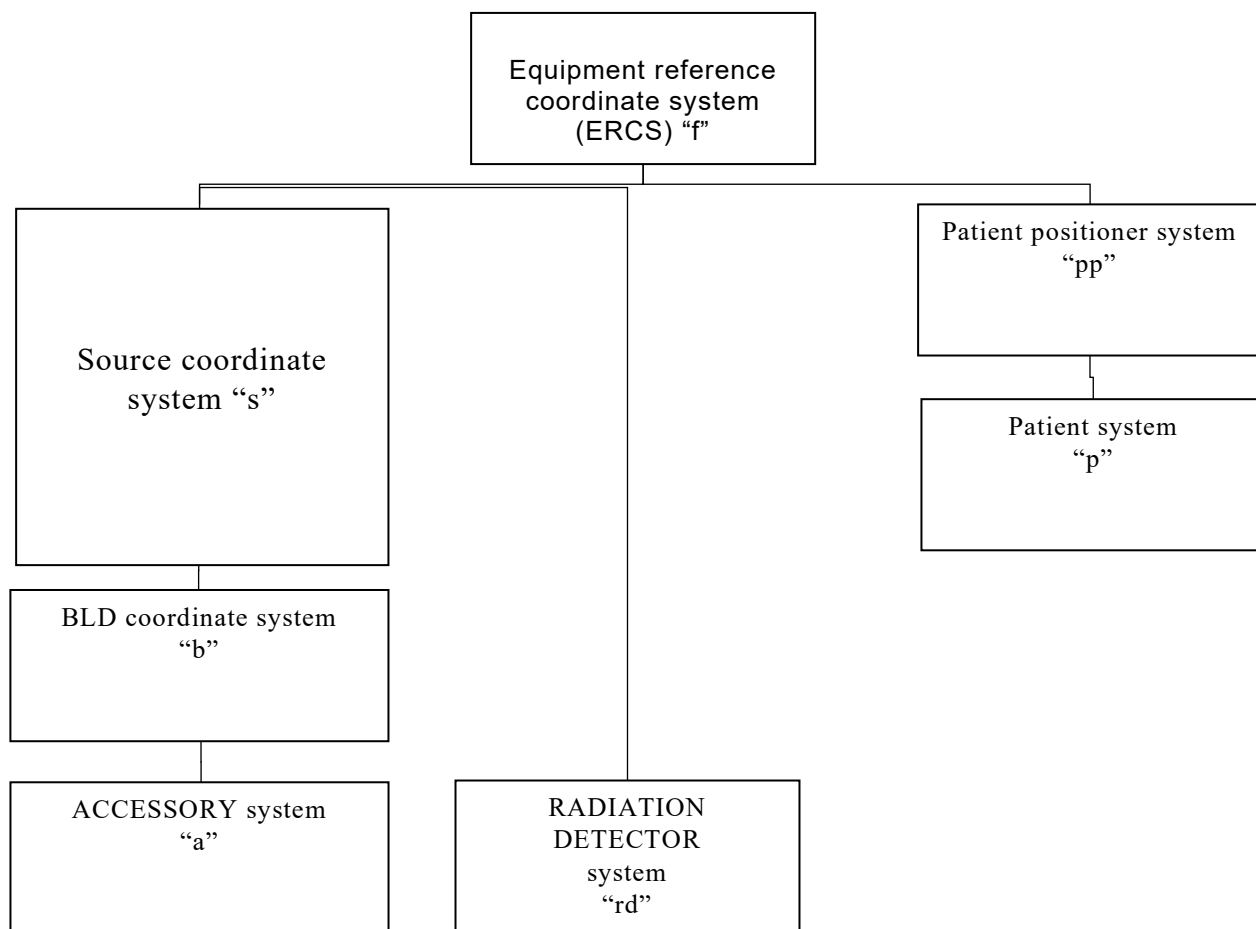
θ = Yaw, or rotation of X and Y around Z

NOTE For the Equipment Reference Coordinate System, X and Y are parallel to the floor and Z is vertically up.

Figure 2 – X Y Z right-hand coordinate mother system (isometric drawing) showing pitch (ψ), roll (ϕ), and yaw (θ) directions of positive rotation for daughter system (see subclause 4.2a)).

- Coordinate axes are identified by a capital letter followed by a lower-case letter, representing coordinate system identification.
- 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 ERCS. Figure 3 and Table 2 show the hierarchical structure which is divided into three sub-hierarchical structures; one in relation to the SOURCE and related equipment, the second in

518 relation to the PATIENT POSITIONER, and the third in relation to the RADIATION DETECTOR
519 system, whether used for imaging or dosimetry.



520 **Figure 3 – Hierarchical structure among coordinate systems (see 4.2e)**

- 522
- 523 f) The position and orientation of each child (or “daughter”) coordinate system (d) is derived
524 from its parent (or “mother”) coordinate system (m) by yaw rotation about the Z_m axis,
525 followed by extrinsic translation of its origin O_d along one or more axes of its mother system
526 and then by intrinsic roll and pitch rotation of the daughter system about the daughter’s
527 translated system Y and X axes, respectively.

528 NOTE 1 Translational mechanical motions of parts of the ME EQUIPMENT may follow a different sequence, as
529 long as the ME EQUIPMENT ends up in the same position as it would have done if the indicated sequence had
530 been followed. Rotational motions must be performed in a prescribed order: YAW (rotation around the Z axis)
531 followed by ROLL (rotation around the Y axis) followed by PITCH (rotation around the X axis).

532 NOTE 2: One may wish to consider YAW to be part of the prescription for radiotherapy, in that in most cases,
533 rotation of the beam-limiting device around its Z axis, or rotation of the patient support around its Z axis are
534 both specified by the treatment plan. In contrast, ROLL and PITCH are generally applied as corrections to the
535 patient position during daily setup.

536 Figures 1b and 1c show examples of translation of the daughter system origin O_d along
537 the mother system coordinate axes X_m , Y_m , Z_m .

538 Figure 1b shows rotation about axis Z_d which is parallel to Z_m followed by translation of
539 origin O_d along X_m , Y_m , Z_m . Subsequent rotation around axis Y_d would be intrinsic.