

AS/NZS 4580:1999
IEC 61852:1998

Australian/New Zealand Standard™

**Medical electrical equipment—
Digital imaging and communications
in medicine (DICOM)—Radiotherapy
objects**

AS/NZS 4580

AS/NZS 4580:1999

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 Australasian Society for Ultrasound in Medicine
 Australian & New Zealand College of Anaesthetists
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Digital imaging and communications
in medicine (DICOM)—Radiotherapy
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PREFACE

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INTRODUCTION

This supplement to the DICOM Standard defines a number of information objects applicable to the domain of radiation oncology. The intent of these objects is to support the transfer of radiotherapy-related data between devices found within and outside a radiotherapy department. They are not, however, intended to support the *management* of the transferred data, a function which may be addressed in future revisions of the DICOM Standard.

This task of process management has not been addressed in the current draft due to the absence of a consistent process model for a radiotherapy department, especially in an international context. As a result, the radiotherapy information objects contain a large number of conditional and optional data elements. Essentially the objects are intended to be used as “containers” for related radiotherapy data, with data being added as the object flows through the department.

AUSTRALIAN/NEW ZEALAND STANDARD

**MEDICAL ELECTRICAL EQUIPMENT –
DIGITAL IMAGING AND COMMUNICATIONS IN MEDICINE (DICOM) –
RADIOTHERAPY OBJECTS**

The following text extends and/or amends Part 3 of DICOM.

Part 3: Addendum radiotherapy information object definitions**1 Scope**

This report specifies the following information objects:

- 1) A DICOM *Image* Information Object for Radiotherapy. It specifies the semantic content of RT Images. It is commonly abbreviated to the RT Image IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Image IOD is radiotherapy images which have been obtained on a conic imaging geometry, such as that found on conventional simulators and portal imaging devices. It can also be used for calculated images using the same geometry, such as digitally reconstructed radiographs (DRRs).
- 2) A DICOM *Dose* Information Object for Radiotherapy. It specifies the semantic content of RT Doses. It is commonly abbreviated to the RT Dose IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Dose IOD is radiotherapy dose distributions which have been calculated on a radiotherapy treatment planning system, represented as two- or three-dimensional dose grids, groups of named or unnamed dose points, isodose curves, and dose-volume histograms (DVHs).
- 3) A DICOM *Structure Set* Information Object for Radiotherapy. It specifies the semantic content of RT Structure Sets. It is commonly abbreviated to the RT Structure Set IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Structure Set IOD is radiotherapy patient-related structures which have been identified on devices such as CT scanners, virtual simulation workstations, or treatment planning systems.
- 4) A DICOM *Plan* Information Object for Radiotherapy. It specifies the semantic content of RT (Treatment) Plans. It is commonly abbreviated to the RT Plan IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Plan IOD is geometric and dosimetric data specifying a course of external beam and/or brachytherapy treatment.

This report includes a number of addenda to existing Parts of DICOM; therefore the reader should have a working understanding of the Standard.

1. Part 3 Addenda (Extension to the body, Annex A, B, C and D)
2. Part 4 Addenda (Extension to Annex B)
3. Part 6 Addenda (Extension to Section 6 and Annex A)

Add to Section 2

2 Normative references

IEC 61217:1996, *Radiotherapy equipment – Coordinates, movements and scales*

ICRU Report 50, *Prescribing, Recording, and Reporting Photon Beam Therapy*, International Commission on Radiation Units and Measurements, 1993

After Section 3.8 add the following:

3.X Radiotherapy

This part of the standard is based on the concepts developed in IEC 61217 and makes use of the following terms defined in it:

- a) FIXED REFERENCE system
- b) GANTRY system
- c) BEAM LIMITING DEVICE system
- d) WEDGE FILTER system
- e) X-RAY IMAGE RECEPTOR system
- f) PATIENT SUPPORT system
- g) TABLE TOP ECCENTRIC system
- h) TABLE TOP system

In Section 4 add the following:

4 Symbols and abbreviations

BEV	Beam's-eye view
Brachy	Brachytherapy
CC	Counter-clockwise
CTV	Clinical target volume
CW	Clockwise
DRR	Digitally-reconstructed radiograph
DVH	Dose-volume histogram
GTV	Gross tumour volume
Gy	Gray
ICRU	International Commission on Radiation Units
IEC	International Electrotechnical Commission
MeV	Mega electron Volt
MLC	Multileaf (multi-element) collimator
MU	Monitor unit
MV	Megavolt
PTV	Planning target volume
R&V	Record and verify
ROI	Region of interest
RT	Radiotherapy
SAD	Source-axis distance
SID	Source-image distance

Add in figure 7-2

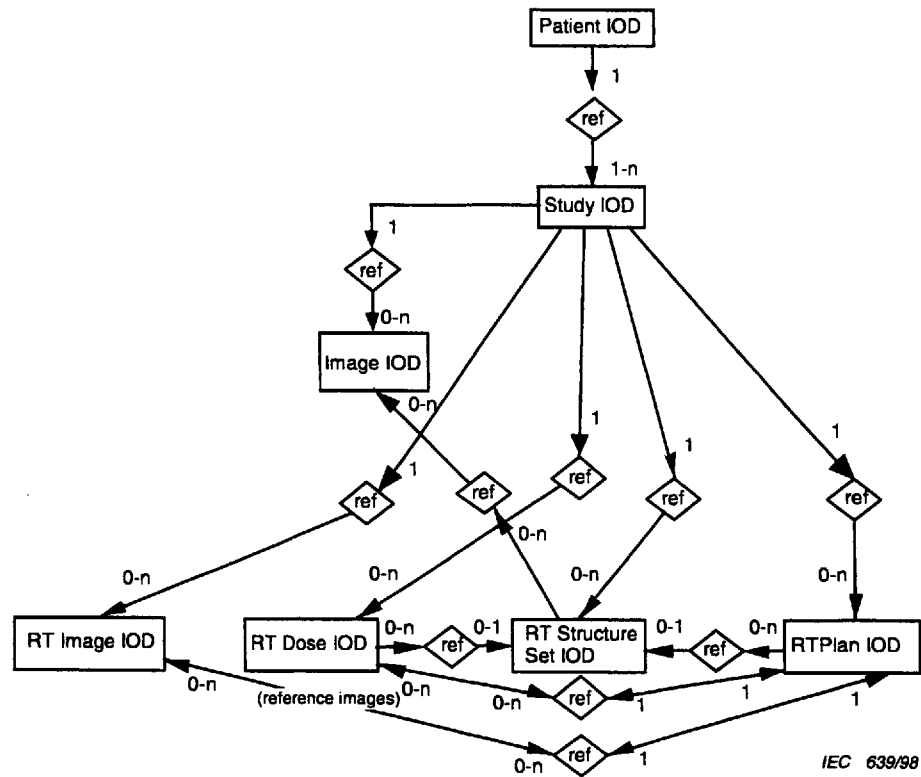


Figure 7-2 – DICOM information model (RT extensions)

Add in table A.1-1 – all modifications to existing table are in **BOLD** type

Table A.1-1– Composite Information Object Modules Overview

IODs Modules	RT Image	RT Dose	RT Struct Set	RT Plan
Patient	M	M	M	M
Patient Summary				
General Study	M	M	M	M
Patient Study	U	U	U	U
Study Content				
General Series				
CR Series				
NM Series				
RT Series	M	M	M	M
Frame Of Reference	U	M		
US Frame of Ref.				
General Equipment	M	M	M	M
NM Equipment				
SC Equipment				
General Image	M	C		
Image Plane		C		
Image Pixel	M	C		
Contrast/Bolus	C			
Cine	C			
Multi-frame	C	C		
CR Image				
CT Image				
MR Image				
NM Image				
NM SPECT				
NM Multi-Gated				
US Region Calibration				
US Image				
SC Image				
RT Image	M			
RT Dose		M		
RT DVH		U		
Structure Set		C	M	
ROI Contour		C	M	
RT Dose ROI		C		
RT ROI Observations			M	
RT General Plan				M
RT Prescription				U
RT Tolerance Tables				U
RT Patient Setup				U
RT Fraction Scheme				U
RT Beams				C
RT Brachy Application Setups				C
Approval	U		U	U
Overlay Identification				
Overlay Plane		U		
Multi-frame Overlay		U		

IODs Modules	RT Image	RT Dose	RT Struct Set	RT Plan
Curve Identification				
Curve	U			
Audio	U	U	U	U
Modality LUT	U	U		
VOI LUT	U			
LUT Identification				
SOP Common	M	M	M	M

* The notation next to M and U indicates a special condition for these modules. Refer to the corresponding Information Object Definitions in this annex for details.

After Section A.14 add the following:

A.U RT Image INFORMATION OBJECT DEFINITION

A.U.1 RT Image IOD Description

The focus for this Radiotherapy Image IOD (RT Image IOD) is to address the requirements for image transfer found in general radiotherapy applications performed on conventional simulators, virtual simulators, and portal imaging devices. Such images have a conical imaging geometry and may either be acquired directly from the device, or digitized using a film digitizer. They may or may not have superimposed curves describing beam limiting device (collimator) openings, beam modifying devices, patient structures and target volumes. Numeric beam data parameters may also be recorded with the image, indicating the parameter values at the time the image was taken or created.

A.U.2 RT Image IOD entity-relationship model

The E-R model for the RT Image IOD is illustrated in figure A.U-1.

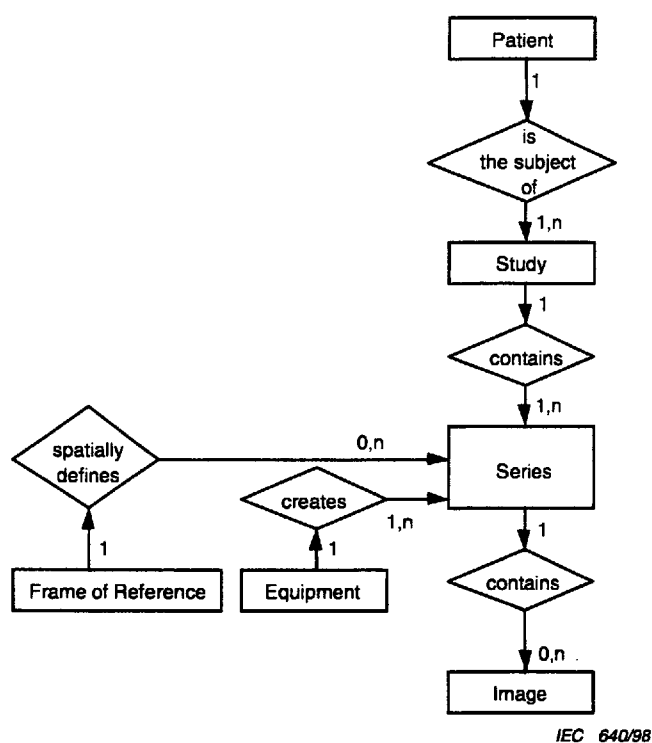


Figure A.U-1 – DICOM RT Image IOD information model

A.U.3 RT Image IOD Module Table

Table A.U.3-1 – RT Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.X.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C – Required if contrast media was used in this image.
	Cine	C.7.6.5	C – Required if multi-frame image is a cine image.
	Multi-Frame	C.7.6.6	C – Required if pixel data is multi-frame data.
	RT Image	C.8.X.2	M
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	Approval	C.8.X.16	U
	Curve	C.10.2	U
	Audio	C.10.3	U
	SOP Common	C.12.1	M

NOTE 1 – The inclusion of the Multi-Frame module allows for the expression of time-dependent image series or multiple exposures of identical beam geometries (i.e. multiple exposure portal images). If a time-dependent series of images (such as port images or DRRs) is represented the Cine module is used to indicate this. This would subsequently allow analysis of patient movement during treatment. Multiple exposure images allow individual images of treatment ports and open field ports to be grouped into a single multi-frame image.

NOTE 2 – The Modality LUT module has been included to allow the possibility of conversion between portal image pixel values and dose transmitted through the patient. The VOI LUT module has been included to allow the possibility of translation between stored pixel values (after the Modality LUT has been applied if specified) and display levels.

NOTE 3 – The Curve module has been included to allow the possibility of storing one or more curves overlaid with a given image. Generally these curves would represent patient structures, target volumes, or beam limiting device (collimator) openings, although they could also be used to store other data such as axis information. Such curves would be stored in pixel units (i.e. the coordinates would represent pixel indices in the image data). For example, patient structures might have the following attribute assignments:

Curve Dimensions (50xx, 0005)	= 2
Number of Points (50xx, 0010)	= Number of data points in curve
Type of Data (50xx, 0020)	= ROI
Data Value Representation (50xx, 0103)	= US (unsigned short)
Curve Data (50xx, 3000)	= (x,y) pixel coordinates
Curve Description (50xx,0022)	= Structure/Target name

Note that there is no facility for representing multi-frame curves (i.e. all curves are interpreted as being related to the first image frame in a multi-frame image). Curves other than patient structures might also be represented using the HIST, POLY or TABL curve types (see P3.3, C.10.2.1).

NOTE 4 – The Equipment module contains information describing the equipment used to acquire or generate the RT Image (such as a portal imager, conventional simulator or treatment planning system). However, the equipment attributes in the RT Image module describe the equipment on which the treatment has been or will be given, typically an electron accelerator.

NOTE 5 – For RT Images which contain no relevant pixel data, such as BEV images without DRR information, Pixel Data (7FE0,0010) should be filled with a sequence of zeros.

NOTE 6 – The Frame of Reference module has been included to allow the indication of spatial association of two or more RT Image instances (e.g. where the images have been acquired in the same frame of reference, or have been resampled to share the same frame of reference). If the Frame of Reference occurs within a SOP Instance within a given series, then all SOP Instances within that series will be spatially related. For example, two RT Images may share the same Frame of Reference if they are located on the same physical plane, as determined by the treatment machine Gantry Angle (300A,011E) and source-to-image plane distance specified by RT Image SID (3002,0026).

A.V RT DOSE INFORMATION OBJECT DEFINITION

A.V.1 RT Dose IOD Description

The focus for this Radiotherapy Dose IOD (RT Dose IOD) is to address the requirements for transfer of dose distributions calculated by radiotherapy treatment planning systems. These distributions may be represented as 2D or 3D grids, as isodose curves, or as named or unnamed dose points scattered throughout the volume. This IOD may also contain dose-volume histogram data, single or multi-frame overlays, audio annotations, and application-defined lookup tables. This IOD does not provide for definition of doses in beam or other coordinate systems. The application is responsible for transforming data in other, non-patient-based coordinate systems to the patient-based coordinate system described in C.7.6.2.1.1.

A.V.2 RT Dose IOD entity-relationship model

The E-R model for the RT Dose IOD is illustrated in figure A.V-1.

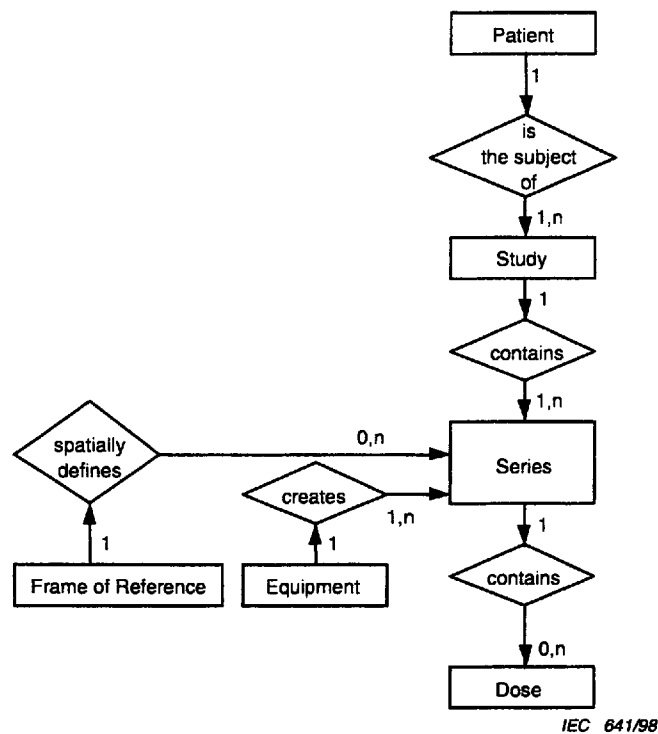


Figure A.V-1 – DICOM RT Dose IOD information model

A.V.3 RT Dose IOD Module Table**Table A.V.3-1 – RT Dose IOD Modules**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.X.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Dose	General Image	C.7.6.1	C – Required if dose data contains grid-based doses.
	Image Plane	C.7.6.2	C – Required if dose data contains grid-based doses.
	Image Pixel	C.7.6.3	C – Required if dose data contains grid-based doses.
	Multi-Frame	C.7.6.6	C – Required if dose data contains grid-based doses and pixel data is multi-frame data.
	Overlay Plane	C.9.2	U
	Multi-Frame Overlay	C.9.3	U
	Modality LUT	C.11.1	U
	RT Dose	C.8.X.3	M
	RT DVH	C.8.X.4	U
	Structure Set	C.8.X.5	C – Required if dose data contains dose points or isodose curves
	ROI Contour	C.8.X.6	C – Required if dose data contains dose points or isodose curves
	RT Dose ROI	C.8.X.7	C – Required if dose data contains dose points or isodose curves
	Audio	C.10.3	U
	SOP Common	C.12.1	M

NOTE 1 – Within the RT Dose IOD, the RT Dose module supports 2D and 3D dose grids. The Structure Set, ROI Contour and RT Dose ROI modules together support isodose curves and points, and the RT DVH module supports dose-volume histogram data. They are not mutually exclusive: all four representations may be included in a single instance of the object or they may be included in any combination. Product Conformance Statements should clearly state which of these mechanisms is supported and under what conditions.

NOTE 2 – The RT Dose IOD has been defined as a composite IOD, separate from the RT Plan IOD. This has been done for the following reasons.

- To allow for the multiplicity of possible dose calculations using beam models for the same basic plan.
- To avoid undesirable transmission of large amounts of data with the treatment plan.
- To accommodate the fact that CT Simulation and other "beam geometry" generating devices which use the RT Plan IOD do not have or require access to this data, either for transmission or storage.

A.W RT STRUCTURE SET INFORMATION OBJECT DEFINITION**A.W.1 RT Structure Set IOD Description**

The focus for this Radiotherapy Structure Set IOD (RT Structure Set IOD) is to address the requirements for transfer of patient structures and related data defined on CT scanners, virtual simulation workstations, treatment planning systems and similar devices. This IOD may also contain audio curve annotations.

A.W.2 RT Structure Set IOD entity-relationship model

The E-R model for the RT Structure Set IOD is illustrated in figure A.W-1.

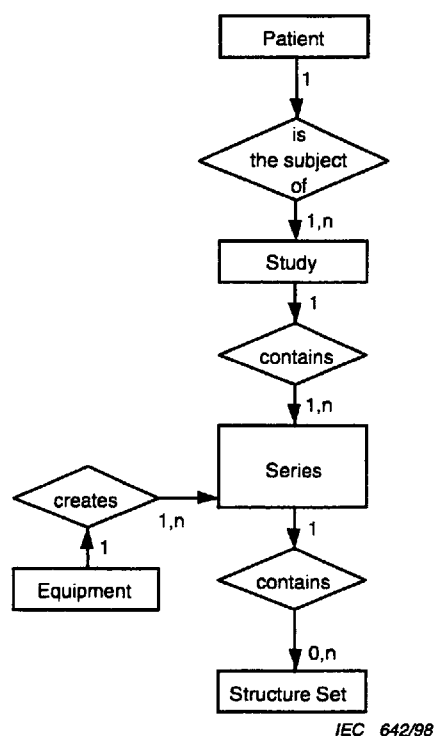


Figure A.W-1 – DICOM RT Structure Set IOD information model

A.W.3 RT Structure Set IOD Module Table

Table A.W.3-1 – RT Structure Set IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.X.1	M
Equipment	General Equipment	C.7.5.1	M
Structure Set	Structure Set	C.8.X.5	M
	ROI Contour	C.8.X.6	M
	RT ROI Observations	C.8.X.8	M
	Approval	C.8.X.16	U
	Audio	C.10.3	U
	SOP Common	C.12.1	M

A.X RT PLAN INFORMATION OBJECT DEFINITION

A.X.1 RT Plan IOD Description

The focus for this Radiotherapy Plan IOD (RT Plan IOD) is to address the requirements for transfer of treatment plans generated by manual entry, a virtual simulation system, or a treatment planning system before or during a course of treatment. Such plans may contain fractionation information, and define external beams and/or brachytherapy application setups. This IOD may also contain audio curve annotations.

A.X.2 RT Plan IOD entity-relationship model

The E-R model for the RT Plan IOD is illustrated in figure A.X-1.

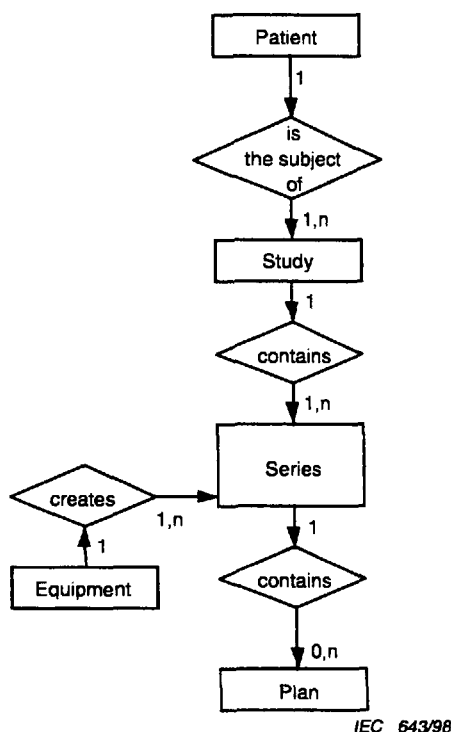


Figure A.X-1 – DICOM RT Plan IOD information model

A.X.3 RT Plan IOD Module Table**Table A.X.3-1 – RT Plan IOD Modules**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.X.1	M
Equipment	General Equipment	C.7.5.1	M
Plan	RT General Plan	C.8.X.9	M
	RT Prescription	C.8.X.10	U
	RT Tolerance Tables	C.8.X.11	U
	RT Patient Setup	C.8.X.12	U
	RT Fraction Scheme	C.8.X.13	U
	RT Beams	C.8.X.14	C – Required if RT Fraction Scheme Module exists and Number of Beams (300A,0080) is greater than zero for one or more fraction groups
	RT Brachy Application Setups	C.8.X.15	C – Required if RT Fraction Scheme Module exists and Number of Brachy Application Setups (300A,00A0) is greater than zero for one or more fraction groups
	Approval	C.8.X.16	U
	Audio	C.10.3	U
	SOP Common	C.12.1	M

A.X.3.1 RT FRACTION SCHEME MODULE

The RT Fraction Scheme module is structured to be used together with the RT Beams or RT Brachy Application Setups module. If beams are referenced in the RT Fraction Scheme module, all such beams shall be included in the RT Beams module if it is present. Similarly, if brachy application setups are referenced in the RT Fraction Scheme module, all such setups shall be included in the RT Brachy Application Setups module if it is present. However, the RT Fraction Scheme module can be used without the RT Beams or RT Brachy Application Setups modules if no beams or brachy application setups are referenced, and the RT Beams or RT Brachy Application Setups modules can also be used without the RT Fraction Scheme module if no fraction scheme information is available.

A.X.3.2 RT PRESCRIPTION MODULE

The RT Prescription module provides for the inclusion of dose prescription information pertinent to the complete plan, which may comprise several fraction schemes, themselves consisting of many beams.

A.X.3.3 RT TOLERANCE TABLES MODULE

The RT Tolerance Tables module provides information concerning machine tolerances as they apply to the whole treatment plan. Tolerances are applied by reference to a tolerance table within the RT Tolerance Tables module for beams contained within the RT Beams module.

A.X.3.4 RT PATIENT SETUP MODULE

The RT Patient Setup module provides information concerning patient setup parameters and fixation devices as they apply to the whole treatment plan. Patient setup information within the RT Patient Setup module is referenced by beams contained within the RT Beams module.

Add new Defined Terms to Section C.7.3.1.1.1

C.7.3.1.1.1 Modality

The following Defined Terms shall be added:

RTIMAGE = Radiotherapy Image
RTDOSE = Radiotherapy Dose
RTSTRUCT = Radiotherapy Structure Set
RTPLAN = Radiotherapy Plan

Add new Sections C.8.X and C.8.X.1 to C.8.X.16

C.8.X Radiotherapy

This section describes Radiotherapy-specific modules.

Modules defined here make reference to IEC coordinate systems and standards. These standards are defined in IEC 61217.

Many of the dosimetry concepts referred to in this document can be found in ICRU Report 50.

C.8.X.1 RT Series Module

There exist significant differences in the manner in which RT objects compare to diagnostic objects. An RT object can be one of several types, and a series of a given object type may be created over a temporal span of several weeks. The RT Series Module has been created to satisfy the requirements of the standard DICOM Query/Retrieve model while including only those attributes relevant to the identification and selection of radiotherapy objects.

Table C.8.X.1-1 – RT Series Module

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data. Enumerated Values: RTIMAGE = RT Image RTDOSE = RT Dose RTSTRUCT = RT Structure Set RTPLAN = RT Plan See C.8.X.1.1.
Series Instance UID	(0020,000E)	1	Unique identifier of the series.
Series Number	(0020,0011)	2	A number that identifies this series.
Series Description	(0008,103E)	3	User-provided description of the series.
Referenced Study Component Sequence	(0008,1111)	3	Uniquely identifies the Study Component SOP Instances to which the series is related. One or more items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Study Component (0008,1111) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Component (0008,1111) is sent.

C.8.X.1.1 Modality

The Enumerated Value for Modality (0008,0060) shall be determined by the IOD.

RTIMAGE if RT Image IOD,
 RTDOSE if RT Dose IOD,
 RTSTRUCT if RT Structure Set IOD,
 RTPLAN if RT Plan IOD.

NOTE – DICOM specifies that a given series shall contain objects of only one Modality, and shall be created by a single device (described in the General Equipment Module). However, in general there may be many series defined for a given modality/device pair. Note that a radiotherapy series is generally created over an extended time interval (unlike in radiology, where all images in an image series are generally created together).

C.8.X.2 RT Image Module

Table C.8.X.2-1 contains attributes that describe RT-specific characteristics of a projection image. The image described by these attributes must be a radiotherapy image acquired or calculated using a conical imaging geometry.

Table C.8.X.2-1 – RT Image Module

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See C.X.2.6.1 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.X.2.6.2 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See C.X.2.6.3 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See C.X.2.6.4 for specialization.
High Bit	(0028,0102)	1	Most significant bit for each pixel sample. Each sample shall have the same high bit. See C.X.2.6.5 for specialization.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. See C.X.2.6.6 for specialization.
RT Image Label	(3002,0002)	1	User-defined label for RT Image.
RT Image Name	(3002,0003)	3	User-defined name for RT Image.
RT Image Description	(3002,0004)	3	User-defined description of RT Image.
Operators' Name	(0008,1070)	2	Name of operator(s) acquiring or creating RT Image.
Image Type	(0008,0008)	1	Image identification characteristics (see DICOM Part 3 Section C.7.6.1.1.2). RT Images shall use one of the following Defined Terms for Value 3: DRR = digitally reconstructed radiograph PORTAL = digital portal image or portal film image SIMULATOR = conventional simulator image RADIOGRAPH = radiographic image BLANK = image pixels set to background value
Conversion Type	(0008,0064)	2	Describes the kind of image conversion. Defined Terms: DV = Digitized Video DI = Digital Interface DF = Digitized Film WSD = Workstation

Reported Values Origin	(3002,000A)	2C	Describes the origin of the parameter values reported in the image. Required if Value 3 of Image Type (0008,0008) is SIMULATOR or PORTAL. Enumerated Values: OPERATOR = manually entered by operator PLAN = planned parameter values ACTUAL = electronically recorded
RT Image Plane	(3002, 000C)	1	Describes whether or not image plane is normal to beam axis. Enumerated Values: NORMAL = image plane normal to beam axis NON_NORMAL = image plane non-normal to beam axis
X-Ray Image Receptor Angle	(3002,000E)	2	X-Ray Image Receptor Angle i.e. orientation of IEC X-RAY IMAGE RECEPTOR coordinate system with respect to IEC GANTRY coordinate system (degrees). See C.8.X.2.2.
RT Image Orientation	(3002,0010)	2C	The direction cosines of the first row and the first column with respect to the IEC X-RAY IMAGE RECEPTOR coordinate system. Required if RT Image Plane (3002,000C) is NON_NORMAL.
Image Plane Pixel Spacing	(3002,0011)	2	Physical distance (in mm) between the centre of each image pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing. See C.8.X.2.3.
RT Image Position	(3002,0012)	2	The x and y coordinates (in mm) of the upper left-hand corner (first pixel transmitted) of the image, in the IEC X-RAY IMAGE RECEPTOR coordinate system.
Radiation Machine Name	(3002,0020)	2	User-defined name identifying radiation machine used in acquiring or computing image (i.e. name of conventional simulator, electron accelerator, X-ray device, or machine modeled when calculating DRR).
Primary Dosimeter Unit	(300A,00B3)	2	Measurement unit of machine dosimeter. Enumerated Values: MU = Monitor Unit MINUTE = minute
Radiation Machine SAD	(3002,0022)	2	Radiation source to Gantry rotation axis distance of radiation machine used in acquiring or computing image (mm).
Radiation Machine SSD	(3002,0024)	3	Source to patient surface distance (in mm) of radiation machine used in acquiring or computing image.
RT Image SID	(3002,0026)	2	Distance from radiation machine source to image plane (in mm) along radiation beam axis. See C.8.X.2.3.

Source to Reference Object Distance	(3002,0028)	3	Source to reference object distance (in mm), as used for magnification calculation of RADIOGRAPH and SIMULATOR images.
Referenced RT Plan Sequence	(300C,0002)	3	Introduces sequence of one Class/Instance pair describing RT Plan associated with image. Only a single item shall be permitted in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced RT Plan Sequence (300C,0002) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced RT Plan Sequence (300C,0002) is sent.
Referenced Beam Number	(300C,0006)	3	Uniquely identifies the corresponding N-segment treatment beam specified by Beam Number (300A,00C0) within Beam Sequence in RT Beams Module within the RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Referenced Fraction Group Number	(300C,0022)	3	Identifier of Fraction Group within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Fraction Number	(3002,0029)	3	Fraction Number of fraction during which image was acquired, within Fraction Group referenced by Referenced Fraction Group Number (300C,0022) within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number (300C,0006) at which image acquisition starts.
End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number (300C,0006) at which image acquisition ends.
Exposure Sequence	(3002,0030)	3	Introduces sequence of Exposure parameter sets, corresponding to exposures used in generating the image. One or more items may be included in this sequence. See C.8.X.2.4.
>Referenced Frame Number	(0008,1160)	1C	Identifies corresponding image frame in multi-frame image. Required if Exposure Sequence (3002,0030) is sent, there is more than one item in Exposure Sequence (3002,0030), and image is a multi-frame image.
>KVP	(0018,0060)	2C	Peak kilo voltage output (kV) of X-ray generator used to acquire image. Required if Value 3 of Image Type (0008,0008) is PORTAL, SIMULATOR or RADIOGRAPH and Exposure Sequence (3002,0030) is sent.

>X-Ray Tube Current	(0018,1151)	2C	Imaging device X-ray Tube Current (mA). Required if Value 3 of Image Type (0008,0008) is SIMULATOR or RADIOGRAPH and Exposure Sequence (3002,0030) is sent.
>Exposure Time	(0018,1150)	2C	Time of X-ray exposure (msec). Required if Value 3 of Image Type (0008,0008) is SIMULATOR or RADIOGRAPH and Exposure Sequence (3002,0030) is sent.
>Meterset Exposure	(3002,0032)	2C	Treatment machine Meterset duration over which image has been acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3). Required if Value 3 of Image Type (0008,0008) is PORTAL and Exposure Sequence (3002,0030) is sent.
>Beam Limiting Device Sequence	(300A,00B6)	3	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) positions for given exposure. One or more items may be included in this sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1C	Type of beam limiting device (collimator). Required if Beam Limiting Device Sequence (300A,00B6) is sent. Enumerated Values: X = symmetric jaw pair in IEC X direction Y = symmetric jaw pair in IEC Y direction ASYMX = asymmetric jaw pair in IEC X direction ASYMY = asymmetric pair in IEC Y direction MLCX = multileaf (multi-element) jaw pair in IEC X direction MLCY = multileaf (multi-element) jaw pair in IEC Y direction
>>Source to Beam Limiting Device Distance	(300A,00BA)	3	Radiation source to beam limiting device (collimator) distance (mm).
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1C	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws). Required if Beam Limiting Device Sequence (300A,00B6) is sent.
>>Leaf Position Boundaries	(300A,00BE)	2C	Boundaries (in mm) of beam limiting device (collimator) leaves (elements) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), i.e. X-axis for MLCY, Y-axis for MLCX. Contains N+1 values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), starting from Leaf (Element) Pair 1. Required if RT Beam Limiting Device Type (300A,00B8) is MLCX or MLCY.

>>Leaf/Jaw Positions	(300A,011C)	1C	Positions of beam limiting device (collimator) leaf or jaw (element) pairs (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g. X-axis for MLCX, Y-axis for MLCY). Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), in IEC leaf (element) subscript order 101, 102, ... 1N, 201, 202, ... 2N. Required if Beam Limiting Device Sequence (300A,00B6) is sent.
>Applicator Sequence	(300A,0107)	3	Introduces sequence of Applicators associated with Beam. Only a single item shall be permitted in this sequence.
>>Applicator ID	(300A,0108)	1C	User or machine supplied identifier for Applicator. Required if Applicator Sequence (300A,0107) is sent.
>>Applicator Type	(300A,0109)	1C	Type of Applicator. Required if Applicator Sequence (300A,0107) is sent. Defined Terms: ELECTRON_SQUARE = square electron applicator ELECTRON_RECT = rectangular electron applicator ELECTRON_CIRC = circular electron applicator ELECTRON_SHORT = short electron applicator ELECTRON_OPEN = open (dummy) electron applicator INTRAOPERATIVE = intraoperative (custom) applicator STEREOTACTIC = stereotactic applicator
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>Number of Blocks	(300A,00F0)	1C	Number of shielding blocks associated with Beam. Required if Exposure Sequence (3002,0030) is sent.
>Block Sequence	(300A,00F4)	2C	Introduces sequence of blocks associated with Beam. Required if Number of Blocks (300A,00F0) is non-zero. One or more items may be included in this sequence.
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray.
>>Source to Block Tray Distance	(300A,00F6)	2C	Radiation Source to attachment edge of block tray assembly (mm). Required if Block Sequence (300A,00F4) is sent.

>>Block Type	(300A,00F8)	1C	Type of block. Required if Block Sequence (300A,00F4) is sent. Enumerated Values: SHIELDING = blocking material is inside contour APERTURE = blocking material is outside contour
>>Block Divergence	(300A,00FA)	2C	Indicates presence or otherwise of geometrical divergence. Required if Block Sequence (300A,00F4) is sent. Enumerated Values: PRESENT = block edges are shaped for beam divergence ABSENT = block edges are not shaped for beam divergence
>>Block Number	(300A,00FC)	1C	Identification Number of the Block. The value of Block Number (300A,00FC) shall be unique within the Beam in which it is created. Required if Block Sequence (300A,00F4) is sent.
>>Block Name	(300A,00FE)	3	User-defined name for block.
>>Material ID	(300A,00E1)	2C	User-supplied identifier for material used to manufacture Block. Required if Block Sequence (300A,00F4) is sent.
>>Block Thickness	(300A,0100)	3	Physical thickness of block (in mm) parallel to radiation beam axis.
>>Block Number of Points	(300A,0104)	2C	Number of (x,y) pairs defining the block edge. Required if Block Sequence (300A,00F4) is sent.
>>Block Data	(300A,0106)	2C	A data stream of (x,y) pairs which comprise the block edge. The number of pairs shall be equal to Block Number of Points (300A,0104), and the vertices shall be interpreted as a closed polygon. Coordinates are projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm). Required if Block Sequence (300A,00F4) is sent.
Gantry Angle	(300A,011E)	3	Treatment machine gantry angle, i.e. orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
Beam Limiting Device Angle	(300A,0120)	3	Treatment machine beam limiting device (collimator) angle, i.e. orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees).
Patient Support Angle	(300A,0122)	3	Patient Support angle, i.e. orientation of IEC PATIENT SUPPORT coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).

Table Top Eccentric Axis Distance	(300A,0124)	3	Distance (positive) from the IEC PATIENT SUPPORT vertical axis to the IEC TABLE TOP ECCENTRIC vertical axis (mm).
Table Top Eccentric Angle	(300A,0125)	3	Table Top (non-isocentric) angle, i.e. orientation of IEC TABLE TOP ECCENTRIC coordinate system with respect to IEC PATIENT SUPPORT system (degrees).
Table Top Vertical Position	(300A,0128)	3	Table Top Vertical position in IEC TABLE TOP coordinate system (mm).
Table Top Longitudinal Position	(300A,0129)	3	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm).
Table Top Lateral Position	(300A,012A)	3	Table Top Lateral position in IEC TABLE TOP coordinate system (mm).

NOTE – The numeric beam data parameters recorded with the RT Image correspond to the parameters as they were known at the time the image was created or taken. The parameters may or may not correspond to an actual RT Plan instance that is created for a patient. If the Reported Values Origin (3002,000A) has an enumerated value of OPERATOR or ACTUAL and there is an RT Plan reference present, the numeric beam data parameters may or may not be the same in the two objects.

C.8.X.2.1 Multi-frame image data

In either multiple exposure multi-frame images or cine images, only the attributes inside of the Exposure Sequence (3002,0030) shall differ between frames. For example, attributes such as beam limiting device (collimator) leaf (element) positions and block information may change, whereas attributes such as gantry and beam limiting device (collimator) angle shall not change.

C.8.X.2.2 X-Ray Image Receptor Angle

The X-Ray Image Receptor Angle (3002,000E) specifies the rotation of the image receptor device in the IEC X-RAY IMAGE RECEPTOR PLANE. A positive angle corresponds to a counter-clockwise rotation of the X-Ray Image Receptor as viewed from the radiation source in the IEC GANTRY coordinate system. The normal (non-rotated) value for this parameter is zero degrees.

C.8.X.2.3 Image Plane Pixel Spacing and RT Image SID

The Image Plane Pixel Spacing (3002,0011) attribute shall always be defined on the image plane, i.e. at the radiation machine source to image plane distance specified by RT Image SID (3002,0026). For images where the source-image distance is undefined or unknown (e.g. DRR images), RT Image SID (3002,0026) shall equal Radiation Machine SAD (3002,0022) and Image Plane Pixel Spacing (3002,0011) shall be defined on this common plane.

C.8.X.2.4 Exposure Sequence

The Exposure Sequence (3002,0030) allows specification of imaging parameters and aperture definitions for single exposure images (single item sequence) or multiple exposures (multiple item sequence). A multiple exposure image can be expressed as a multi-frame image containing either a single frame, or more than one frame. Referenced Frame Number (0008,1160) shall be specified for each Exposure Sequence item for multiple exposure images expressed using more than one frame.

C.8.X.2.5 Single frame and multi-frame images

If the Multi-frame Module is present and the Cine Module is not present then the Frame Increment Pointer (0028,0009) shall have the Enumerated Value of 00200013 (Image Number). If the Multi-frame Module and Cine Module are both present then the Frame Increment Pointer (0028,0009) shall have an Enumerated Value of either 00181063 (Frame Time) or 00181065 (Frame Time Vector).

C.8.X.2.6 Image Pixel Module Attributes**C.8.X.2.6.1 Samples per pixel**

For RT Images, Samples per Pixel (0028,0002) shall have the Enumerated Value of 0001H.

C.8.X.2.6.2 Photometric interpretation

For RT Images, Photometric Interpretation (0028,0004) shall have the Enumerated Value of MONOCHROME2.

C.8.X.2.6.3 Bits allocated

For RT Images, Bits Allocated (0028,0100) shall have an Enumerated Value of 8 or 16.

C.8.X.2.6.4 Bits stored

For RT Images, Bits Stored (0028,0101) shall have an Enumerated Value of:

8 when Bits Allocated (0028,0100) is 8

12-16 when Bits Allocated (0028,0100) is 16

C.8.X.2.6.5 High bit

For RT Images, High Bit (0028,0102) shall have the Enumerated Value of one less than the value sent in Bits Stored (0028,0101).

C.8.X.2.6.6 Pixel representation

For RT Images, Pixel Representation (0028,0103) shall have the Enumerated Value of 0000H (unsigned integer).

C.8.X.3 RT Dose Module

The RT Dose module is used to convey 2D or 3D radiation dose data generated from treatment planning systems or similar devices. The attributes defined within the module support dose for a single radiation beam (potentially comprised of multiple segments, as delivered in a dynamic treatment) or a group of beams comprising either a fraction group (see C.8.X.13) or a complete treatment plan (potentially the sum of multiple fraction groups).

The RT Dose module provides the mechanism to transmit a 3D array of dose data as a set of 2D dose planes which may or may not be related to CT or MR image planes. This mechanism works via the DICOM Multi-Frame module which is required if multi-frame pixel data are sent.