TECHNICAL REPORT

IEC 61852

First edition
1998-04

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

Reference number
IEC 61852:1998(E)

Numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series.

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Terminology, graphical and letter symbols

For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams.*

* See web site address on title page.

TECHNICAL REPORT – TYPE 3

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE XC

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

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- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but no immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 61852, which is a technical report of type 3, has been prepared by subcommittee 62C: Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC technical committee 62: Electrical equipment in medical practice.

The text of this technical report is based on the following documents:

Committee draft	Report on voting
62C/183/CDV	62C/201A/RVC

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

This report has been developed in conjunction with IEC subcommittee 62C, CEN TC251 and the AAPM.

ACR (the American College of Radiology) and NEMA (the National Electrical Manufacturers' Association) formed a joint committee to develop a standard for digital imaging and communications in medicine. This DICOM standard was developed according to the NEMA Procedures.

This report is supplement 11 to the DICOM standard. It is an extension to Part 3, 4 and 6 of the published DICOM standard which consists of the following parts:

Part 1 — Introduction and Overview
Part 2 — Conformance
Part 3 — Information Object Definitions
Part 4 — Service Class Specifications
Part 5 — Data Structures and Encoding
Part 6 — Data Dictionary
Part 7 — Message Exchange
Part 8 — Network Communication Support for Message Exchange
Part 9 — Point-to-Point Communication Support for Message Exchange
Part 10 — Media Storage and File Format
Part 11 — Media Storage Application Profiles
Part 12 — Media Formats and Physical Media
Part 13 — Print Management Point-to-Point Communication Support

These parts are independent but related documents. Their development level and approval status may differ. Additional parts may be added to this multi-part standard. PS3.1 should be used as the base reference for the current parts of this standard.

A bilingual version of this technical report may be issued at a later date.

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.

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

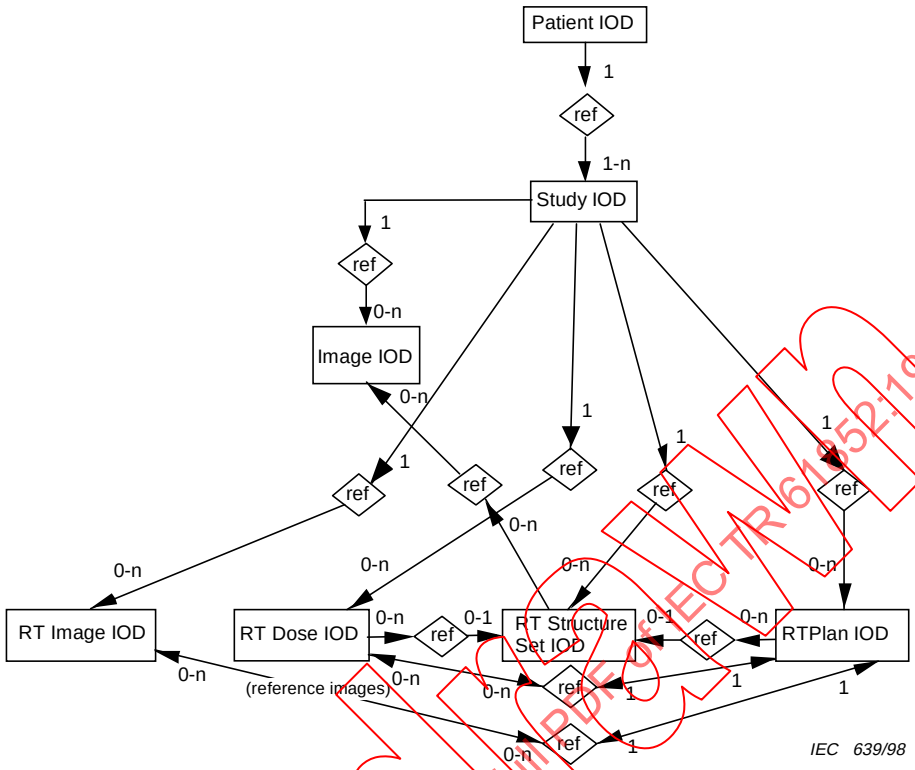

Figure 7-2 – DICOM information model (RT extensions)

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.

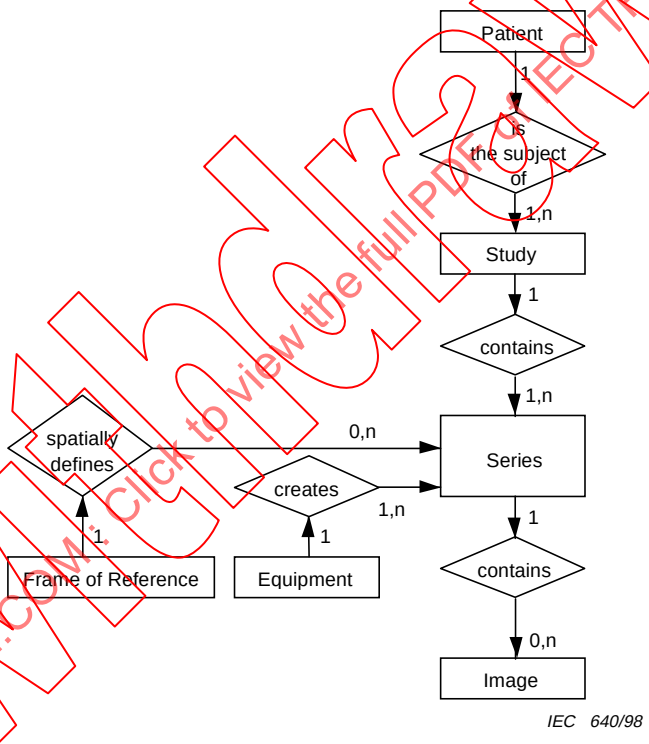

Figure A.U-1 – DICOM RT Image IOD information model

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.

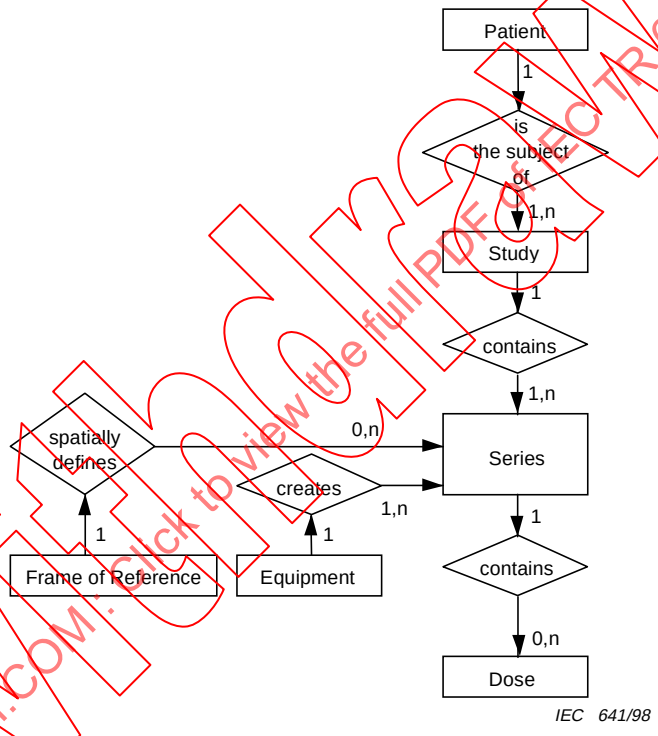

Figure A.V-1 – DICOM RT Dose IOD information model

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.

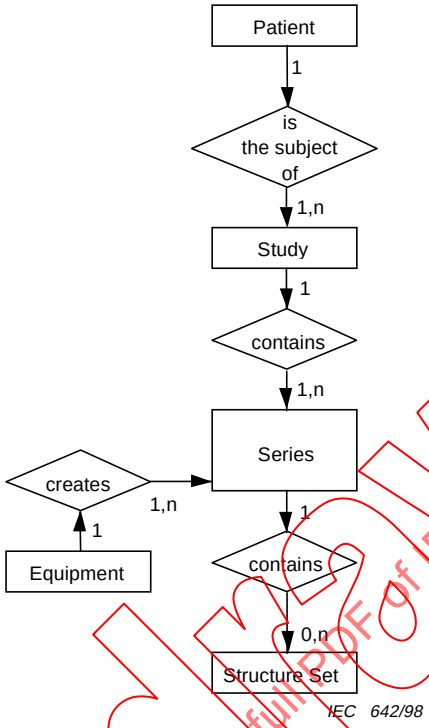

Figure A.W-1 – DICOM RT Structure Set IOD information model

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.

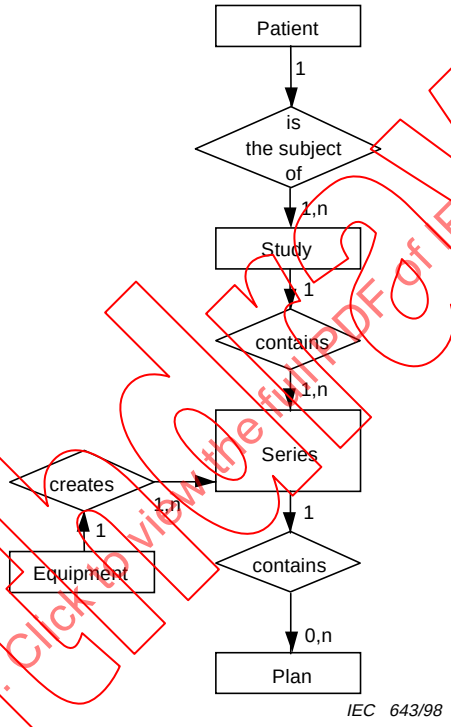

Figure A.X-1 – DICOM RT Plan IOD information model

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.

Table C.8.X.3-1 – RT Dose Module

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1C	Number of samples (planes) in this image. See C.X.3.4.1 for specialization. Required if Pixel Data (7FE0,0010) is present.
Photometric Interpretation	(0028,0004)	1C	Specifies the intended interpretation of the pixel data. See C.X.3.4.2 for specialization. Required if Pixel Data (7FE0,0010) is present.
Bits Allocated	(0028,0100)	1C	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See C.X.3.4.3 for specialization. Required Pixel Data (7FE0,0010) is present.
Bits Stored	(0028,0101)	1C	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See C.X.3.4.4 for specialization. Required if Pixel Data (7FE0,0010) is present.
High Bit	(0028,0102)	1C	Most significant bit for each pixel sample. Each sample shall have the same high bit. See C.X.3.4.5 for specialization. Required if Pixel Data (7FE0,0010) is present.
Pixel Representation	(0028,0103)	1C	Data representation of the pixel samples. Each sample shall have the same pixel representation. See C.X.3.4.6 for specialization. Required Pixel Data (7FE0,0010) is present.
Dose Units	(3004,0002)	1	Units used to describe dose. Enumerated Values: GY = Gray RELATIVE = dose relative to implicit reference value
Dose Type	(3004,0004)	1	Type of dose. Defined Terms: PHYSICAL = physical dose EFFECTIVE = physical dose after correction for biological effect using user-defined modeling technique ERROR = difference between desired and planned dose
Dose Comment	(3004,0006)	3	User-defined comments for dose data.
Normalization Point	(3004,0008)	3	Coordinates (x, y, z) of normalization point in the patient-based coordinate system described in C.7.6.2.1.1 (mm). See C.8.X.3.1.
Dose Summation Type	(3004,000A)	1	Type of dose summation. Defined Terms: PLAN = dose calculated for entire RT Plan FRACTION = dose calculated for a single Fraction Group within RT Plan BEAM = dose calculated for one or more Beams within RT Plan BRACHY = dose calculated for one or more Brachy Application Setups within RT Plan

Referenced RT Plan Sequence	(300C,0002)	1C	Introduces sequence of one Class/Instance pair describing RT Plan associated with dose. Required if Dose Summation Type (3004,000A) is PLAN, FRACTION, BEAM, or BRACHY. Only a single item shall be permitted in this sequence. See Note 1.
>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 Fraction Group Sequence	(300C,0020)	1C	Introduces sequence of one Fraction Group containing beams or brachy application setups contributing to dose. Required if Dose Summation Type (3004,000A) is FRACTION, BEAM, or BRACHY. Only a single item shall be permitted in this sequence. See Note 1.
>>Referenced Fraction Group Number	(300C,0022)	1C	Uniquely identifies Fraction Group specified by Fraction Group Number (300A,0071) in Fraction Group Sequence of RT Fraction Scheme Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002). Required if Referenced Fraction Group Sequence (300C,0020) is sent.
>>Referenced Beam Sequence	(300C,0004)	1C	Introduces sequence of Beams in current Fraction Group contributing to dose. Required if Dose Summation Type (3004,000A) is BEAM. One or more items may be included in this sequence.
>>>Referenced Beam Number	(300C,0006)	1C	Uniquely identifies Beam specified by Beam Number (300A,00C0) in Beam Sequence of RT Beams Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002). Required if Referenced Beam Sequence (300A,0004) is sent.
>>Referenced Brachy Application Setup Sequence	(300C,000A)	1C	Introduces sequence of Brachy Application Setups in current Fraction Group contributing to dose. Required if Dose Summation Type (3004,000A) is BRACHY. One or more items may be included in this sequence.
>>>Referenced Brachy Application Setup Number	(300C,000C)	1C	Uniquely identifies Brachy Application Setup specified by Brachy Application Setup Number (300A,0234) in Brachy Application Setup Sequence (300A,0230) of RT Brachy Application Setups Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002). Required if Referenced Brachy Application Setup Sequence (300C,000A) is sent.

Grid Frame Offset Vector	(3004,000C)	1C	An array which contains the z coordinates (in mm) of the image frames in a multi-frame dose. Required if multi-frame pixel data are present and Frame Increment Pointer (0028,0009) points to Grid Frame Offset Vector (3004,000C). See C.8.X.3.2.
Dose Grid Scaling	(3004,000E)	1	Dimensionless scaling factor converting dose data into dose units specified in Dose Units (3004,0002).

NOTE 1 – In order to prevent misrepresentation of dose summation components, if the Dose Summation Type (3004,000A) is PLAN then only a single instance of RT Plan is referenced (i.e. component fraction groups are not referenced). Similarly, if the Dose Summation Type (3004,000A) is FRACTION then only a single instance of RT Plan and a single Fraction Group are referenced (i.e. component beams or brachy application setups are not referenced).

C.8.X.3.1 Normalization Point

The Normalization Point (3004,0008) aids in the interpretation and subsequent use of the transmitted data. If used, it shall be a point receiving dose contributions from all referenced components of the dose summation.

C.8.X.3.2 Grid Frame Offset Vector

Grid Frame Offset Vector (3004,000C) shall be provided if a dose distribution is sent as a multi-frame image. This attribute contains an array of *n* elements indicating the plane location of the data. This attribute is conditional since the RT Dose module may be included even if pixel doses are not being transmitted, or the image may be a single-frame image. If the Multi-frame Module is present, Frame Increment Pointer (0028,0009) shall have the Enumerated Value of 3004000C (Grid Frame Offset Vector).

C.8.X.3.3 Dose Units

Dose Units are specified in both the RT Dose and RT Dose ROI modules. The attribute Dose Type present in the RT Dose module shall apply to all doses present in the RT Dose IOD.

C.8.X.3.4 Image Pixel Module Attributes

C.8.X.3.4.1 Samples per pixel

For RT Doses, Samples per Pixel (0028,0002) shall have the Enumerated Value of 1.

C.8.X.3.4.2 Photometric interpretation

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

C.8.X.3.4.3 Bits allocated

For RT Doses, Bits Allocated (0028,0100) shall have an Enumerated Value of 16 or 32.

C.8.X.3.4.4 Bits stored

For RT Doses, Bits Stored (0028,0101) shall have an Enumerated Value equal to Bits Allocated (0028,0100).

C.8.X.3.4.5 High bit

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

C.8.X.3.4.6 Pixel representation

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

C.8.X.4 RT DVH Module

The RT DVH module provides for the inclusion of differential or cumulative dose volume histogram data. The data contained within this module may supplement dose data in the RT Dose and/or RT Dose ROI modules, or it may be present in the absence of other dose data.

Table C.8.X.4-1 – RT DVH Module

Attribute Name	Tag	Type	Attribute Description
Referenced Structure Set Sequence	(300C,0060)	1	Introduces sequence of one class/instance pair describing Structure Set containing structures which are used to calculate Dose-Volume Histograms (DVHs). Only a single item shall be permitted in this sequence. See C.8.X.4.1.
>Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.
DVH Normalization Point	(3004,0040)	3	Coordinates (x, y, z) of common DVH normalization point in the patient based coordinate system described in C.7.6.2.1.1 (mm).
DVH Normalization Dose Value	(3004,0042)	3	Dose Value at DVH Normalization Point (3004,0040) used as reference for individual DVHs when Dose Units (3004,0002) is RELATIVE.
DVH Sequence	(3004,0050)	1	Introduces sequence of DVHs. One or more items may be included in this sequence.
>DVH Referenced ROI Sequence	(3004,0060)	1	Introduces sequence of referenced ROIs used to calculate DVH.
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies ROI used to calculate DVH specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by referenced RT Plan in Referenced RT Plan Sequence (300C,0002) in RT Dose Module.
>>DVH ROI Contribution Type	(3004,0062)	1	Specifies whether volume within ROI is included or excluded in DVH. See C.8.X.4.2. Enumerated Values: INCLUDED, EXCLUDED.

>DVH Type	(3004,0001)	1	Type of DVH. Enumerated Values: DIFFERENTIAL = differential dose-volume histogram CUMULATIVE = cumulative dose-volume histogram
>Dose Units	(3004,0002)	1	Dose axis units. Enumerated Values: GY = Gray RELATIVE = dose relative to reference value specified in DVH Normalization Dose Value (3004,0042)
>Dose Type	(3004,0004)	1	Type of dose. Defined Terms: PHYSICAL = physical dose EFFECTIVE = physical dose after correction for biological effect using user-defined modeling technique ERROR = difference between desired and planned dose
>DVH Dose Scaling	(3004,0052)	1	Dimensionless scaling factor converting dose values found in DVH Data (3004,0058) into dose units specified in Dose Units (3004,0002).
>DVH Volume Units	(3004,0054)	1	Volume axis units. Defined Terms: CM3 = cubic centimetres PER CENT = per cent
>DVH Number of Bins	(3004,0056)	1	Number of bins n used to store DVH Data (3004,0058).
>DVH Data	(3004,0058)	1	A data stream describing the dose bin widths D_n and associated volumes V_n in the order D_1V_1, D_2V_2, ... D_nV_n.
>DVH Minimum Dose	(3004,0070)	3	Minimum calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060).
>DVH Maximum Dose	(3004,0072)	3	Maximum calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060).
>DVH Mean Dose	(3004,0074)	3	Mean calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060).

C.8.X.4.1 Referenced Structure Set Sequence

The Referenced Structure Set Sequence (300C,0060) is required for direct cross-reference of the dose bin data with the corresponding ROI(s) from which they were derived. ROIs referenced by the DVH Referenced ROI Sequence (3004,0050) shall only contain contours with a Contour Geometric Type (3006,0042) of POINT or CLOSED_PLANAR.

C.8.X.4.2 DVH ROI Contribution Type

The volume used to calculate the DVH shall be the geometric union of ROIs where DVH ROI Contribution Type (3004,0062) is INCLUDED, minus the geometric union of ROIs where DVH ROI Contribution Type (3004,0062) is EXCLUDED.

C.8.X.5 Structure Set Module

A structure set defines a set of areas of significance. Each area can be associated with a Frame of Reference and zero or more images. Information which can be transferred with each region of interest (ROI) includes geometrical and display parameters, and generation technique.

Table C.8.X.5-1 – Structure Set Module

Attribute Name	Tag	Type	Attribute Description
Structure Set Label	(3006,0002)	1	User-defined label for Structure Set.
Structure Set Name	(3006,0004)	3	User-defined name for Structure Set.
Structure Set Description	(3006,0006)	3	User-defined description for Structure Set.
Structure Set Date	(3006,0008)	2	Date at which Structure Set was last modified.
Structure Set Time	(3006,0009)	2	Time at which Structure Set was last modified.
Referenced Frame of Reference Sequence	(3006,0010)	3	Introduces sequence of items describing Frames of Reference in which the ROIs are defined. One or more items may be included in this sequence. See C.8.X.5.1.
>Frame of Reference UID	(0020,0052)	1C	Uniquely identifies Frame of Reference within Structure Set. Required if Referenced Frame of Reference Sequence (3006,0010) is sent.
>Frame of Reference Relationship Sequence	(3006,00C0)	3	Introduces sequence of transforms that relate other Frames of Reference to this Frame of Reference.
>>Related Frame of Reference UID	(3006,00C2)	1C	Frame of Reference Coordinate System to be transformed to the current Frame of Reference. Required if Frame of Reference Relationship Sequence (3006,00C0) is sent.
>>Frame of Reference Transformation Type	(3006,00C4)	1C	Type of Transformation. Required if Frame of Reference Relationship Sequence (3006,00C0) is sent. Defined Terms: HOMOGENEOUS
>>Frame of Reference Transformation Matrix	(3006,00C6)	1C	Four-by-four transformation Matrix from Related Frame of Reference to current Frame of Reference. Matrix elements shall be listed in row-major order. Required if Frame of Reference Relationship Sequence (3006,00C0) is sent. See C.8.X.5.2.
>> Frame of Reference Transformation Comment	(3006,00C8)	3	Comment regarding the transformation between the related and current Frames of Reference.
>RT Referenced Study Sequence	(3006,0012)	3	Introduces sequence of Studies containing series to be referenced. 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 RT Referenced Study Sequence (3006,0012) is sent.

>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if RT Referenced Study Sequence (3006,0012) is sent.
>>RT Referenced Series Sequence	(3006,0014)	1C	Introduces sequence of items describing series of images within the referenced study which are used in defining the Structure Set. Required if RT Referenced Study Sequence (3006,0012) is sent. One or more items may be included in this sequence.
>>>Series Instance UID	(0020,000E)	1C	Unique identifier for the series containing the images. Required if RT Referenced Series Sequence (3006,0014) is sent.
>>>Contour Image Sequence	(3006,0016)	1C	Introduces sequence of items describing images in a given series used in defining the Structure Set (typically CT or MR images). Required if RT Referenced Series Sequence (3006,0014) is sent. One or more items may be included in this sequence.
>>>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced image SOP Class. Required if Contour Image Sequence (3006,0016) is sent.
>>>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced image SOP Instance. Required if Contour Image Sequence (3006,0016) is sent.
>>>>Referenced Frame Number	(0008,1160)	3	Identifies image frame if a multi-frame image is referenced.
Structure Set ROI Sequence	(3006,0020)	3	Introduces sequence of ROIs for current Structure Set. One or more items may be included in this sequence.
>ROI Number	(3006,0022)	1C	Identification number of the ROI. The value of ROI Number (3006,0022) shall be unique within the Structure Set in which it is created. Required if Structure Set ROI Sequence (3006,0020) is sent.
>Referenced Frame of Reference UID	(3006,0024)	1C	Uniquely identifies Frame of Reference in which ROI is defined, specified by Frame of Reference UID (0020,0052) in Referenced Frame of Reference Sequence (3006,0010). Required if Structure Set ROI Sequence (3006,0020) is sent.
>ROI Name	(3006,0026)	2C	User-defined name for ROI. Required if Structure Set ROI Sequence (3006,0020) is sent.
>ROI Description	(3006,0028)	3	User-defined description for ROI.
>ROI Volume	(3006,002C)	3	Volume of ROI (cubic centimetres).

>ROI Generation Algorithm	(3006,0036)	2C	Type of algorithm used to generate ROI. Required if Structure Set ROI Sequence (3006,0020) is sent. Defined Terms: AUTOMATIC = calculated ROI SEMIAUTOMATIC = ROI calculated with user assistance MANUAL = user-entered ROI
>ROI Generation Description	(3006,0038)	3	User-defined description of technique used to generate ROI.

C.8.X.5.1 Frames of Reference

The Referenced Frame of Reference Sequence (3006,0010) describes a set of frames of reference in which some or all of the ROIs are expressed. Since the Referenced Frame of Reference UID (3006,0024) is required for each ROI, each frame of reference used to express the coordinates of an ROI shall be listed in the Referenced Frame of Reference Sequence (3006,0010) once and only once.

NOTE 1 – As an example, a set of ROIs defined using a single image series would list the image series in a single Referenced Frame of Reference Sequence (3006,0010) item, providing the UID for this referenced frame of reference (obtained from the source images), and listing all pertinent images in the Contour Image Sequence (3006,0016).

NOTE 2 – As an example, a set of ROIs containing ROIs referencing more than one frame of reference would list the referenced images in two or more different Referenced Frame of Reference Sequence (3006,0010) items, providing in each case the UID for this referenced frame of reference (obtained from the source images), and listing all pertinent images in the Contour Image Sequence (3006,0016). Each ROI would then reference the appropriate Frame of Reference UID (0020,0052).

C.8.X.5.2 Frame of Reference Transformation Matrix

In a rigid body system, two coordinate systems can be related using a single 4 × 4 transformation matrix to describe any rotations and/or translations necessary to transform coordinates from the related coordinate system (frame of reference) to the primary system. The equation performing the transform from a point (X',Y',Z') in the related coordinate system to a point (X,Y,Z) in the current coordinate system can be shown as follows, where for homogeneous transforms $M_{41} = M_{42} = M_{43} = 0$ and $M_{44} = 1$:

$$\begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} & M_{14} \\ M_{21} & M_{22} & M_{23} & M_{24} \\ M_{31} & M_{32} & M_{33} & M_{34} \\ M_{41} & M_{42} & M_{43} & M_{44} \end{bmatrix} \times \begin{bmatrix} X' \\ Y' \\ Z' \\ 1 \end{bmatrix}$$

C.8.X.6 ROI Contour Module

In general, a ROI can be defined by either a sequence of overlays or a sequence of contours. This module, if present, is used to define the ROI as a set of contours. Each ROI contains a sequence of one or more contours, where a contour is either a single point (for a point ROI) or more than one point (representing an open or closed polygon).

Table C.8.X.6-1 – ROI Contour Module

Attribute Name	Tag	Type	Attribute Description
ROI Contour Sequence	(3006,0039)	1	Introduces sequence of Contour Sequences defining ROIs. One or more items may be included in this sequence.
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI described in the Structure Set ROI Sequence (3006,0020).
>ROI Display Colour	(3006,002A)	3	RGB triplet colour representation for ROI, specified using the range 0-255.
>Contour Sequence	(3006,0040)	3	Introduces sequence of Contours defining ROI. One or more items may be included in this sequence.
>>Contour Image Sequence	(3006,0016)	3	Introduces sequence of images containing the contour. One or more items may be included in this sequence.
>>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced image SOP Class of the image containing the Contour, if it exists. Required if Contour Image Sequence (3006,0016) is sent.
>>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced image SOP Instance of the image containing the Contour, if it exists. Required if Contour Image Sequence (3006,0016) is sent.
>>>Referenced Frame Number	(0008,1160)	1C	Identifies image frame if a multi-frame image is referenced. Required if referenced image is a multi-frame image.
>>Contour Geometric Type	(3006,0042)	1C	Geometric type of contour. Required if Contour Sequence (3006,0040) is sent. See C.8.X.6.1. Enumerated Values: POINT = single point OPEN_PLANAR = open contour containing coplanar points OPEN_NONPLANAR = open contour containing non-coplanar points CLOSED_PLANAR = closed contour (polygon) containing coplanar points
>>Contour Slab Thickness	(3006,0044)	3	Thickness of slab (in mm) represented by contour, where the Contour Data (3006,0050) defines a plane in the centre of the slab, offset by the Contour Offset Vector (3006,0045) if it is present. See C.8.X.6.2.

>>Contour Offset Vector	(3006,0045)	3	Vector (x,y,z) in the patient-based coordinate system described in C.7.6.2.1.1 which is normal to plane of Contour Data (3006,0050), describing direction and magnitude of the offset (in mm) of each point of the central plane of a contour slab from the corresponding original point of Contour Data (3006,0050). See C.8.X.6.2.
>>Number of Contour Points	(3006,0046)	1C	Number of points (triplets) in Contour Data (3006,0050). Required if Contour Sequence (3006,0040) is sent.
>>Contour Data	(3006,0050)	1C	Sequence of (x,y,z) triplets defining a contour in the patient based coordinate system described in C.7.6.2.1.1 (mm). Required if Contour Sequence (3006,0040) is sent. See C.8.X.6.1.

C.8.X.6.1 Contour Geometric Type

A contour can be one of the following geometric types:

– A Contour Geometric Type (3006,0042) of POINT indicates that the contour is a single point, defining a specific location of significance.

– A Contour Geometric Type (3006,0042) of OPEN_PLANAR indicates that the last vertex shall *not* be connected to the first point, and that all points in Contour Data (3006,0050) shall be coplanar.

– A Contour Geometric Type (3006,0042) of OPEN_NONPLANAR indicates that the last vertex shall *not* be connected to the first point, and that the points in Contour Data (3006,0050) may be non-coplanar. Contours having a Geometric Type (3006,0042) of OPEN_NONPLANAR can be used to represent objects best described by a single, possibly non-coplanar curve, such as a brachytherapy applicator.

– A Contour Geometric Type (3006,0042) of CLOSED_PLANAR indicates that the last point shall be connected to the first point, where the first point is not repeated in the Contour Data (3006,0050). All points in Contour Data (3006,0050) shall be coplanar.

C.8.X.6.2 Contour Slab Thickness

A set of Contour slabs may define a multi-slab Volume of Interest. Contour Slab Thickness (3006,0044) shall specify the thickness of a slab, the central plane of which shall be defined by the set of points offset from Contour Data (3006,0050) by the value of Contour Offset Vector (3006,0045). One contour slab may contain one to many sets of Contour Data (3006,0050) that may define regions of one complex Volume of Interest. If no valid value of Contour Slab Thickness (3006,0044) is sent, then the offset value shall be (0,0,0) and the original Contour Data (3006,0050) shall define the central plane of the Contour slab.

C.8.X.7 RT Dose ROI Module

RT Dose ROI provides ancillary dose-related information to the ROI data defined within the Structure Set and ROI Contour modules, which may be included in the RT Dose IOD composite object. These modules in combination provide for the definition of dose data in the form of isodose curves or named or unnamed dose points. Isodose curves in radiation oncology are simply contours identifying a set of points with the same dose value.

Table C.8.X.7-1 – RT Dose ROI Module

Attribute Name	Tag	Type	Attribute Description
RT Dose ROI Sequence	(3004,0010)	1	Introduces sequence of items specifying dose levels for isodose curves or dose points described in the ROI module. One or more items may be included in this sequence. See C.8.X.7.1.
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI within the current RT Dose. See Note 1 and C.8.X.7.2.
>Dose Units	(3004,0002)	1	Units used for ROI Dose. Enumerated Values: GY = Gray RELATIVE = dose relative to implicit reference value
>Dose Value	(3004,0012)	1	Dose value for ROI, in units defined by Dose Units (3004,0002). See C.8.X.7.3.

NOTE 1 – The Structure Set ROI Sequence (3006,0020) defining the dose point and surfaces is defined in the Structure Set module. The ROI Number (3006,0022) attribute is unique within the Structure Set ROI Sequence, and is referenced from the RT Dose ROI module using Referenced ROI Number (3006,0084).

NOTE 2 – The RT Dose ROI module defines the attributes that describe references to ROIs contained within the associated Structure Set and RT ROI Contour modules. Note that the RT Dose module table specifies that either all or none of the modules Structures Set, ROI Contour, and RT Dose ROI must be present in the RT Dose IOD.

C.8.X.7.1 Contour Geometric Type of Referenced ROI

ROIs referenced in the RT Dose ROI Module shall have a Contour Geometric Type (3006,0042) of POINT, OPEN_PLANAR or CLOSED_PLANAR.

C.8.X.7.2 Referenced ROI Number

There shall be a one-to-one correspondence between Referenced ROI Number (3006,0084) and the sequence of ROIs defined in the Structure Set and ROI Contour modules. The RT Dose ROI module shall only contain references to structures which are dose-related (i.e. dose points and isodose curves).

C.8.X.7.3 Dose Value

Dose Value (3004,0012) shall be the dose value corresponding to the referenced isodose curve, named dose point, or unnamed dose point.

C.8.X.8 RT ROI Observations Module

The RT ROI Observations module specifies the identification and interpretation of an ROI specified in the Structure Set and ROI Contour modules.

Table C.8.X.8-1 – RT ROI Observations Module

Attribute Name	Tag	Type	Attribute Description
RT ROI Observations Sequence	(3006,0080)	1	Introduces sequence of observations related to ROIs defined in the ROI Module. One or more items may be included in this sequence.
>Observation Number	(3006,0082)	1	Identification number of the Observation. The value of Observation Number (3006,0082) shall be unique within the RT ROI Observations Sequence (3006,0080).
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI described in the Structure Set ROI Sequence (3006,0020).
>ROI Observation Label	(3006,0085)	3	User-defined label for ROI Observation
>ROI Observation Description	(3006,0088)	3	User-defined description for ROI Observation.
>RT Related ROI Sequence	(3006,0030)	3	Introduces sequence of significantly related ROIs, e.g. CTVs contained within a PTV. One or more items may be included in this sequence.
>>Referenced ROI Number	(3006,0084)	1C	Uniquely identifies the related ROI described in the Structure Set ROI Sequence (3006,0020). Required if RT Related ROI Sequence (3006,0030) is sent.
>>RT ROI Relationship	(3006,0033)	3	Relationship of referenced ROI with respect to referencing ROI. Defined Terms: SAME = ROIs represent the same entity ENCLOSED = referenced ROI completely encloses referencing ROI ENCLOSING = referencing ROI completely encloses referenced ROI
>RT ROI Identification Code Sequence	(3006,0086)	3	Introduces sequence containing Code used to identify ROI. If this sequence is included, only one item shall be present. Baseline Context ID Number = 96. See PS 3.3 Section 5.3 for further explanation.
>>Code Value	(0008,0100)	1C	Identifier within Coding Scheme which identifies ROI. Required if RT ROI Identification Code Sequence (3006,0086) is sent. See PS 3.3 Section 5.3 for further explanation.
>>Coding Scheme Designator	(0008,0102)	1C	Uniquely identifies the table (Coding Scheme) where the Code Value (0008,0100) is linked to its Code Meaning (0008,0104). Required if RT ROI Identification Code Sequence (3006,0086) is sent. See PS 3.3 Section 5.3 for further explanation.

>>Code Meaning	(0008,0104)	3	Human-readable text interpretation of Code Value (0008,0100). See PS 3.3 Section 5.3 for further explanation.
>Related RT ROI Observations Sequence	(3006,00A0)	3	Introduces sequence of related ROI Observations. One or more items may be included in this sequence.
>>Observation Number	(3006,0082)	1C	Uniquely identifies a related ROI Observation. Required if Related RT ROI Observations Sequence (3006,00A0) is sent.
>RT ROI Interpreted Type	(3006,00A4)	2	Type of ROI. See C.8.X.8.1. Defined Terms: EXTERNAL = external patient contour PTV = Planning Target Volume (as defined in ICRU50) CTV = Clinical Target Volume (as defined in ICRU50) GTV = Gross Tumour Volume (as defined in ICRU50) TREATED_VOLUME = Treated Volume (as defined in ICRU50) IRRAD_VOLUME = Irradiated Volume (as defined in ICRU50) BOLUS = patient bolus to be used for external beam therapy AVOIDANCE = region in which dose is to be minimized ORGAN = patient organ MARKER = patient marker REGISTRATION = registration ROI ISOCENTER = treatment isocentre to be used for external beam therapy CONTRAST_AGENT = volume into which a contrast agent has been injected CAVITY = patient anatomical cavity BRACHY_CHANNEL = brachytherapy channel BRACHY_ACCESSORY = brachytherapy accessory device BRACHY_SRC_APP = brachytherapy source applicator BRACHY_CHNL_SHLD = brachytherapy channel shield
>ROI Interpreter	(3006,00A6)	2	Name of person performing the interpretation.
>Material ID	(300A,00E1)	3	User-supplied identifier for ROI material.
>ROI Physical Properties Sequence	(3006,00B0)	3	Introduces sequence describing physical properties associated with current ROI interpretation. One or more items may be included in this sequence.

>>ROI Physical Property	(3006,00B2)	1C	Physical property specified by ROI Physical Property Value (3006,00B4). Required if ROI Physical Properties Sequence (3006,00B0) is sent. Defined Terms: REL_MASS_DENSITY = mass density relative to water REL_ELEC_DENSITY = electron density relative to water EFFECTIVE_Z = effective atomic number EFF_Z_PER_A = effective ratio of atomic number to mass (AMU^{-1})
>>ROI Physical Property Value	(3006,00B4)	1C	User-assigned value for physical property. Required if ROI Physical Properties Sequence (3006,00B0) is sent.

C.8.X.8.1

RT ROI Interpreted Type (3006,00A4) shall describe the class of ROI (e.g. CTV, PTV). Individual instances of each class of structure (e.g. CTV1, CTV2) can be distinguished using ROI Observation Label (3006,0085).

C.8.X.9 RT General Plan Module

Table C.8.X.9-1 – RT General Plan Module

Attribute Name	Tag	Type	Attribute Description
RT Plan Label	(300A,0002)	1	User-defined label for treatment plan.
RT Plan Name	(300A,0003)	3	User-defined name for treatment plan.
RT Plan Description	(300A,0004)	3	User-defined description of treatment plan.
Operators' Name	(0008,1070)	2	Name of operator(s) creating treatment plan.
RT Plan Date	(300A,0006)	2	Date treatment plan was last modified.
RT Plan Time	(300A,0007)	2	Time treatment plan was last modified.
Treatment Protocols	(300A,0009)	3	Planned treatment protocols.
Treatment Intent	(300A,000A)	3	Intent of this course of treatment. Defined Terms: CURATIVE, PALLIATIVE, PROPHYLACTIC.
Treatment Sites	(300A,000B)	3	Planned treatment sites.
RT Plan Geometry	(300A,000C)	1	Describes whether RT Plan is based on patient or treatment device geometry. See C.8.X.9.1. Defined Terms: PATIENT = RT Structure Set exists TREATMENT_DEVICE = RT Structure Set does not exist
Referenced Structure Set Sequence	(300C,0060)	1C	Introduces sequence of one Class/Instance pair describing instance of RT Structure Set on which the RT Plan is based. Only a single item shall be permitted in this sequence. Required if RT Plan Geometry (300A,000C) is PATIENT.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Structure Set Sequence (300C,0060) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Structure Set Sequence (300C,0060) is sent.
Referenced Dose Sequence	(300C,0080)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Dose (for grids and named/unnamed point doses). One or more items may be included in this sequence. See Note 1.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced RT Dose Sequence (300C,0080) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced RT Dose Sequence (300C,0080) is sent.

Referenced RT Plan Sequence	(300C,0002)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Plan. 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 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.
>RT Plan Relationship	(300A,0055)	1C	Relationship of referenced plan with respect to current plan. Required if Referenced RT Plan Sequence (300C,0002) is sent. Defined Terms: PRIOR = plan delivered prior to current treatment ALTERNATIVE = alternative plan prepared for current treatment PREDECESSOR = plan used in derivation of current plan

NOTE 1 – An RT Dose IOD referenced within the Referenced Dose Sequence (300C,0080) can be used for storing grid-based (pixel) data, individual dose points (with optional dose point names), isodose curves, and DVHs.

C.8.X.9.1 Referenced Structure Set Sequence

An RT Plan Geometry (300A,000C) of PATIENT shall signify that an RT Structure Set has been defined upon which the plan geometry is based, and this RT Structure Set shall be specified in the Referenced Structure Set Sequence (300C,0060). An RT Plan Geometry (300A,000C) of TREATMENT_DEVICE shall indicate that no patient geometry is available, and that the RT Plan is being defined with respect to the IEC FIXED Coordinate System.

C.8.X.10 RT Prescription Module

Table C.8.X.10-1 – RT Prescription Module

Attribute Name	Tag	Type	Attribute Description
Prescription Description	(300A,000E)	3	User-defined description of treatment prescription.
Dose Reference Sequence	(300A,0010)	3	Introduces sequence of Dose References. One or more items may be included in this sequence.
>Dose Reference Number	(300A,0012)	1C	Identification number of the Dose Reference. The value of Dose Reference Number (300A,0012) shall be unique within the RT Plan in which it is created. Required if Dose Reference Sequence (300A,0012) is sent.
>Dose Reference Structure Type	(300A,0014)	1C	Structure type of Dose Reference. Required if Dose Reference Sequence (300A,0010) is sent. Defined Terms: POINT = dose reference point specified as ROI VOLUME = dose reference volume specified as ROI COORDINATES = point specified by Dose Reference Point Coordinates (300A,0018) SITE = dose reference clinical site
>Dose Reference Description	(300A,0016)	3	User-defined description of Dose Reference.
>Referenced ROI Number	(3006,0084)	1C	Uniquely identifies ROI representing the dose reference specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Dose Reference Structure Type (300A,0014) is POINT or VOLUME and Dose Reference Sequence (300A,0010) is sent.
>Dose Reference Point Coordinates	(300A,0018)	1C	Coordinates (x,y,z) of Reference Point in the patient based coordinate system described in C.7.6.2.1.1 (mm). Required if Dose Reference Structure Type (300A,0014) is COORDINATES and Dose Reference Sequence (300A,0010) is sent.
>Nominal Prior Dose	(300A,001A)	3	Dose (in Gy) from prior treatment to this Dose Reference (e.g. from a previous course of treatment).
>Dose Reference Type	(300A,0020)	1C	Type of Dose Reference. Required if Dose Reference Sequence (300A,0010) is sent. Defined Terms: TARGET = treatment target (corresponding to GTV, PTV, or CTV in ICRU50) ORGAN_AT_RISK = Organ at Risk (as defined in ICRU50)

>Constraint Weight	(300A,0021)	3	Relative importance of satisfying constraint, where high values represent more important constraints.
>Delivery Warning Dose	(300A,0022)	3	The dose (in Gy) which when reached or exceeded should cause some action to be taken.
>Delivery Maximum Dose	(300A,0023)	3	The maximum dose (in Gy) which can be delivered to the dose reference.
>Target Minimum Dose	(300A,0025)	3	Minimum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Prescription Dose	(300A,0026)	3	Prescribed dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Maximum Dose	(300A,0027)	3	Maximum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Underdose Volume Fraction	(300A,0028)	3	Maximum permitted fraction (in per cent) of Target to receive less than the Target Prescription Dose if Dose Reference Type (300A,0020) is TARGET and Dose Reference Structure Type (300A,0014) is VOLUME. See C.8.X.10.1.
>Organ at Risk Full-volume Dose	(300A,002A)	3	Maximum dose (in Gy) to entire Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Limit Dose	(300A,002B)	3	Maximum permitted dose (in Gy) to any part of Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Maximum Dose	(300A,002C)	3	Maximum dose (in Gy) to non-overdosed part of Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Overdose Volume Fraction	(300A,002D)	3	Maximum permitted fraction (in per cent) of the Organ at Risk to receive more than the Organ at Risk Maximum Dose if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.

C.8.X.10.1 Target Underdose Volume Fraction

If the Target Underdose Volume Fraction (300A,0028) is not present, it shall be interpreted as zero.

C.8.X.11 RT Tolerance Tables Module

Table C.8.X.11-1 – RT Tolerance Tables Module

Attribute Name	Tag	Type	Attribute Description
Tolerance Table Sequence	(300A,0040)	3	Introduces sequence of tolerance tables to be used for delivery of treatment plan. One or more items may be included in this sequence. See Note 1.
>Tolerance Table Number	(300A,0042)	1C	Identification number of the Tolerance Table. The value of Tolerance Table Number (300A,0042) shall be unique within the RT Plan in which it is created. Required if Tolerance Table Sequence (300A,0040) is sent.
>Tolerance Table Label	(300A,0043)	3	User-defined label for Tolerance Table.
>Gantry Angle Tolerance	(300A,0044)	3	Maximum permitted difference (in degrees) between planned and delivered Gantry Angle.
>Beam Limiting Device Angle Tolerance	(300A,0046)	3	Maximum permitted difference (in degrees) between planned and delivered Beam Limiting Device Angle.
>Beam Limiting Device Tolerance Sequence	(300A,0048)	3	Introduces sequence of beam limiting device (collimator) tolerances. 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 Tolerance Sequence (300A,0040) 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
>>Beam Limiting Device Position Tolerance	(300A,004A)	1C	Maximum permitted difference (in mm) between planned and delivered leaf (element) or jaw positions for current beam limiting device (collimator). Required if Beam Limiting Device Tolerance Sequence (300A,0040) is sent.
>Patient Support Angle Tolerance	(300A,004C)	3	Maximum permitted difference (in degrees) between planned and delivered Patient Support Angle.
>Table Top Eccentric Angle Tolerance	(300A,004E)	3	Maximum permitted difference (in degrees) between planned and delivered Table Top Eccentric Angle.

>Table Top Vertical Position Tolerance	(300A,0051)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Vertical Position.
>Table Top Longitudinal Position Tolerance	(300A,0052)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Longitudinal Position.
>Table Top Lateral Position Tolerance	(300A,0053)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Lateral Position.

NOTE 1 – Tolerance Tables may be used to compare planned with delivered machine parameters. If the absolute difference between the planned and delivered values exceeds the Tolerance Table value, treatment may be inhibited or the operator may be warned.

C.8.X.12 RT Patient Setup Module

The RT Patient Setup Module contains information describing the positioning of the patient with respect to the treatment machine, along with any fixation devices used. It also describes the shielding devices applied to the patient. The module contains a sequence of patient setup descriptions, each of which may be referenced by one of more beams or brachy application setups.

Table C.8.X.12-1 – RT Patient Setup Module

Attribute Name	Tag	Type	Attribute Description
Patient Setup Sequence	(300A,0180)	1	Introduces sequence of patient setup data for current plan. One or more items may be included in this sequence.
>Patient Setup Number	(300A,0182)	1	Identification number of the Patient Setup. The value of Patient Setup Number (300A,0182) shall be unique within the RT Plan in which it is created.
>Patient Position	(0018,5100)	1C	Patient position descriptor relative to the equipment. Required if Patient Additional Position (300A,0184) is not present. See DICOM Part 3 Section C.7.3.1.1.2 for Defined Terms and further explanation.
>Patient Additional Position	(300A,0184)	1C	User-defined additional description of patient position. Required if Patient Position (0018,5100) is not present.
>Fixation Device Sequence	(300A,0190)	3	Introduces sequence of Fixation Devices used in Patient Setup. One or more items may be included in this sequence.
>>Fixation Device Type	(300A,0192)	1C	Type of Fixation Device used during in Patient Setup. Required if Fixation Device Sequence (300A,0190) is sent. Defined Terms: BITEBLOCK, HEADFRAME, MASK, MOLD, CAST, HEADREST, BREAST_BOARD.
>>Fixation Device Label	(300A,0194)	2C	User-defined label identifier for Fixation Device. Required if Fixation Device Sequence (300A,0190) is sent.
>>Fixation Device Description	(300A,0196)	3	User-defined description of Fixation Device.
>>Fixation Device Position	(300A,0198)	3	Position/Notch number of Fixation Device.
>Shielding Device Sequence	(300A,01A0)	3	Introduces sequence of Shielding Devices used in Patient Setup. One or more items may be included in this sequence.
>>Shielding Device Type	(300A,01A2)	1C	Type of Shielding Device used in Patient Setup. Required if Shielding Device Sequence (300A,01A0) is sent. Defined Terms: GUM, EYE, GONAD.
>>Shielding Device Label	(300A,01A4)	2C	User-defined label for Shielding Device. Required if Shielding Device Sequence (300A,01A0) is sent.

>>Shielding Device Description	(300A,01A6)	3	User-defined description of Shielding Device.
>>Shielding Device Position	(300A,01A8)	3	Position/Notch number of Shielding Device.
>Setup Technique	(300A,01B0)	3	Setup Technique used in Patient Setup. Defined Terms: ISOCENTRIC, FIXED_SSD, TBI, BREAST_BRIDGE, SKIN_APPOSITION.
>Setup Technique Description	(300A,01B2)	3	User-defined description of Setup Technique.
>Setup Device Sequence	(300A,01B4)	3	Introduces sequence of devices used for patient alignment in Patient Setup. One or more items may be included in this sequence.
>>Setup Device Type	(300A,01B6)	1C	Type of Setup Device used for Patient alignment. Required if Setup Device Sequence (300A,01B4) is sent. Defined Terms: LASER_POINTER, DISTANCE_METER, TABLE_HEIGHT, MECHANICAL_PTR, ARC.
>>Setup Device Label	(300A,01B8)	2C	User-defined label for Setup Device used for patient alignment. Required if Setup Device Sequence (300A,01B4) is sent.
>>Setup Device Description	(300A,01BA)	3	User-defined description for Setup Device used for patient alignment.
>>Setup Device Parameter	(300A,01BC)	2C	Setup Parameter for Setup Device in appropriate IEC 61217 coordinate system. Units shall be millimetres for distances and angles for degrees. Required if Setup Device Sequence (300A,011B4) is sent.
>>Setup Reference Description	(300A,01D0)	3	User-defined description of Setup Reference used for patient alignment.
>Table Top Vertical Setup Displacement	(300A,01D2)	3	Vertical Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e. vertical offset between patient positioning performed using setup and treatment position.
>Table Top Longitudinal Setup Displacement	(300A,01D4)	3	Longitudinal Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e. longitudinal offset between patient positioning performed using setup and treatment position.
>Table Top Lateral Setup Displacement	(300A,01D6)	3	Lateral Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e. lateral offset between patient positioning performed using setup and treatment position.

C.8.X.13 RT Fraction Scheme Module

The RT Fraction Scheme module contains attributes that describe a single or multiple scheme of dose descriptions. Each sequence item contains dose specification information, fractionation patterns, and either beam or brachytherapy application setup specifications. The design of the RT Fraction Scheme module allows a beam or brachytherapy application setup to be used in multiple fraction schemes.

Table C.8.X.13-1 – RT Fraction Scheme Module

Attribute Name	Tag	Type	Attribute Description
Fraction Group Sequence	(300A,0070)	1	Introduces sequence of Fraction Groups in current Fraction Scheme. One or more items may be included in this sequence.
>Fraction Group Number	(300A,0071)	1	Identification number of the Fraction Group. The value of Fraction Group Number (300A,0071) shall be unique within the RT Plan in which it is created.
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Patient Setup specified by Patient Setup Number (300A,0182) within Patient Setup Sequence (300A,0180) in RT Patient Setup Module.
>Referenced Dose Sequence	(300C,0080)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Dose (for grids, isodose curves and named/unnamed point doses). One or more items may be included in this sequence. See Note 1.
>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Dose Sequence (300C,0080) is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Dose Sequence (300C,0080) is sent.
>Referenced Dose Reference Sequence	(300C,0050)	3	Introduces sequence of Dose References for the current Fraction Group. One or more items may be included in this sequence.
>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) within Dose Reference Sequence (300A,0010) in RT Prescription Module. Required if Referenced Dose Reference Sequence (300C,0050) is sent.
>>Constraint Weight	(300A,0021)	3	Relative importance of satisfying constraint, where high values represent more important constraints.
>>Delivery Warning Dose	(300A,0022)	3	The dose (in Gy) which when reached or exceeded should cause some action to be taken.
>>Delivery Maximum Dose	(300A,0023)	3	The maximum dose (in Gy) which can be delivered to the dose reference.

>>Target Minimum Dose	(300A,0025)	3	Minimum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Prescription Dose	(300A,0026)	3	Prescribed dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Maximum Dose	(300A,0027)	3	Maximum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Underdose Volume Fraction	(300A,0028)	3	Maximum permitted fraction (in perc ent) of Target to receive less than the Target Prescription Dose (300A,0027) if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Full-volume Dose	(300A,002A)	3	Maximum dose (in Gy) to entire Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Limit Dose	(300A,002B)	3	Maximum permitted dose (in Gy) to any part of Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Maximum Dose	(300A,002C)	3	Maximum dose (in Gy) to non-overdosed part of Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Overdose Volume Fraction	(300A,002D)	3	Maximum permitted fraction (in per cent) of Organ at Risk to receive more than the Organ at Risk Maximum Dose if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>Number of Fractions Planned	(300A,0078)	2	Total number of treatments (Fractions) prescribed for current Fraction Group.
>Number of Fractions Per Day	(300A,0079)	3	Total number of treatments (Fractions) prescribed per day for current Fraction Group. See Note 2.

>Repeat Fraction Cycle Length	(300A,007A)	3	Number of weeks needed to describe treatment pattern. See Note 2.
>Fraction Pattern	(300A,007B)	3	String of 0s (no treatment) and 1s (treatment) describing treatment pattern. Length of string is 7 × Number of Fractions Per Day × Repeat Cycle Length. Pattern shall start on a Monday. See Note 2.
>Number of Beams	(300A,0080)	1	Number of Beams in current Fraction Group. If Number of Beams is greater then zero, Number of Brachy Application Setups (300A,00A0) shall equal zero.
>Referenced Beam Sequence	(300C,0004)	1C	Introduces sequence of treatment beams in current Fraction Group. Required if Number of Beams (300A,0080) is greater than zero. One or more items may be included in this sequence.
>>Referenced Beam Number	(300C,0006)	1C	Uniquely identifies Beam specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module. Required if Referenced Beam Sequence (300C,0004) is sent.
>>Beam Dose Specification Point	(300A,0082)	3	Coordinates (x,y,z) of point at which Beam Dose is specified in the patient based coordinate system described in C.7.6.2.1.1 (mm). See Note 3.
>>Beam Dose	(300A,0084)	3	Dose (in Gy) at Beam Dose Specification Point (300A,0082) due to current Beam.
>>Beam Meterset	(300A,0086)	3	Machine setting to be delivered for current Beam, specified in Monitor Units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3) (in RT Beams Module) for referenced Beam. See Note 4.
>Number of Brachy Application Setups	(300A,00A0)	1	Number of Brachy Application Setups in current Fraction Group. If Number of Brachy Application Setups is greater then zero, Number of Beams (300A,0080) shall equal zero.
>Referenced Brachy Application Setup Sequence	(300C,000A)	1C	Introduces sequence of treatment Brachy Application Setups in current Fraction Group. Required if Number of Brachy Application Setups (300A,00A0) is greater than zero. One or more items may be included in this sequence.
>>Referenced Brachy Application Setup Number	(300C,000C)	1C	Uniquely identifies Brachy Application Setup specified by Brachy Application Setup Number (300A,0234) within Brachy Application Setup Sequence (300A,0230) in RT Brachy Application Setups Module. Required if Referenced Brachy Application Setup Sequence (300C,000A) is sent.

>>Brachy Application Setup Dose Specification Point	(300A,00A2)	3	Coordinates (x,y,z) of point in the patient-based coordinate system described in C.7.6.2.1.1 at which Brachy Application Setup Dose (300A,00A4) is specified (mm).
>>Brachy Application Setup Dose	(300A,00A4)	3	Dose (in Gy) at Brachy Application Setup Dose Specification Point (300A,00A2) due to current Brachy Application Setup.

NOTE 1 – An RT Dose IOD referenced within the Referenced Dose Sequence (300C,0080) can be used for storing grid-based (pixel) data, isodose curves, and/or individual dose points (with optional dose point names) for the current Fraction Group.

NOTE 2 – The fractionation pattern does not indicate the actual start of treatment. If treatment does not commence as outlined in the pattern, it is the application's responsibility to make any necessary adjustments.

Examples of Fractionation Pattern Schemes:

a) 1 fraction group, 1 fraction per day (Monday to Friday):

Number of Fractions per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 1111100

b) 2 fraction groups, 1 fraction per day, first fraction group Monday, Wednesday, and Friday, second fraction group Tuesday and Thursday:

Fraction Group 1: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 1010100

Fraction Group 2: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 0101000

c) 2 fraction groups, 1 fraction per day, alternating fraction groups every day of treatment (Monday to Friday):

Fraction Group 1: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 10101000101000

Fraction Group 2: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 01010001010100

d) 1 fraction group, 2 fractions per day (Monday to Friday):

Fraction Group 1: Number of Fractions Per Day = 2, Repeat Fraction Cycle Length = 1, Fraction Pattern = 11111111110000

e) 2 fraction groups, 2 fractions per day, alternating fraction groups every treatment (Monday to Friday):

Fraction Group 1: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 10101010100000

Fraction Group 2: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 01010101010000

NOTE 3 – The Beam Dose Specification Point (300A,0082) and Brachy Application Setup Dose Specification Point (300A,00A2) contain the coordinates of the single point used for dose normalization. This point is distinct from the Referenced Dose Reference Sequence (300C,0050) in the RT Beams module and the Brachy Referenced Dose Reference Sequence (300A,0055) in the RT Brachy Application Setups module, which are used for plan evaluation and dose tracking.

NOTE 4 – The Meterset at a given Control Point (see RT Beams Module) is equal to the Beam Meterset (300A,0086) multiplied by the Cumulative Meterset Weight (300A,0134) for the Control Point, divided by the Final Cumulative Meterset Weight (300A,010E).

C.8.X.14 RT Beams Module

The RT Beams Module contains information defining equipment parameters for delivery of external radiation beams.

Table C.8.X.14-1 – RT Beams Module

Attribute Name	Tag	Type	Attribute Description
Beam Sequence	(300A,00B0)	1	Introduces sequence of treatment beams for current RT Plan. One or more items may be included in this sequence.
>Beam Number	(300A,00C0)	1	Identification number of the Beam. The value of Beam Number (300A,00C0) shall be unique within the RT Plan in which it is created.
>Beam Name	(300A,00C2)	3	User-defined name for Beam.
>Beam Description	(300A,00C3)	3	User-defined description for Beam.
>Beam Type	(300A,00C4)	1	Motion characteristic of Beam. Enumerated Values: STATIC = all beam parameters remain unchanged during delivery DYNAMIC = one or more beam parameters changes during delivery
>Radiation Type	(300A,00C6)	2	Particle type of Beam. Defined Terms: PHOTON, ELECTRON, NEUTRON, PROTON.
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine to be used for beam delivery. See Note 1.
>Manufacturer	(0008,0070)	3	Manufacturer of the equipment to be used for beam delivery.
>Institution Name	(0008,0080)	3	Institution where the equipment is located that is to be used for beam delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that is to be used for beam delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that is to be used for beam delivery.
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that is to be used for beam delivery.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that is to be used for beam delivery.
>Primary Dosimeter Unit	(300A,00B3)	3	Measurement unit of machine dosimeter. See C.8.X.14.1. Enumerated Values: MU = Monitor Unit MINUTE = minute

>Referenced Tolerance Table Number	(300C,00A0)	3	Uniquely identifies Tolerance Table specified by Tolerance Table Number (300A,0042) within Tolerance Table Sequence in RT Tolerance Tables Module. These tolerances are to be used for verification of treatment machine settings.
>Source-Axis Distance	(300A,00B4)	3	Radiation source to Gantry rotation axis distance of the equipment that is to be used for beam delivery (mm).
>Beam Limiting Device Sequence	(300A,00B6)	1	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) sets. One or more items may be included in this sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). 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 of the equipment that is to be used for beam delivery (mm).
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).
>>Leaf Position Boundaries	(300A,00BE)	2C	Boundaries of beam limiting device (collimator) leaves (in mm) 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 Beam Limiting Device Sequence (300A,00B6) is sent and RT Beam Limiting Device Type (300A,00B8) is MLCX or MLCY. See Note 2.
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Patient Setup to be used for current beam, specified by Patient Setup Number (300A,0182) within Patient Setup Sequence of RT Patient Setup Module.
>Referenced Reference Image Sequence	(300C,0042)	3	Introduces sequence of reference images used for validation of current beam. 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 Reference Image Sequence (300C,0042) is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Reference Image Sequence (300C,0042) is sent.
>>Reference Image Number	(300A,00C8)	1C	Uniquely identifies Reference Image within Referenced Reference Image Sequence (300A,0042). Required if Referenced Reference Image Sequence (300A,0042) is sent.
>>Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within current Beam at which image acquisition starts.
>>End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within current Beam at which image acquisition ends.
>Planned Verification Image Sequence	(300A,00CA)	3	Introduces sequence of planned verification images to be acquired during current beam. One or more items may be included in this sequence. See C.8.X.14.2.
>>Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within current Beam at which image acquisition will start.
>>Meterset Exposure	(3002,0032)	3	Meterset duration over which image is to be acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3).
>>End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within current Beam at which image acquisition will end.
>>RT Image Plane	(3002, 000C)	3	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)	3	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.14.3.
>>RT Image Orientation	(3002,0010)	3	The direction cosines of the first row and the first column with respect to the IEC X-RAY IMAGE RECEPTOR coordinate system.
>>RT Image Position	(3002,0012)	3	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.
>>RT Image SID	(3002,0026)	3	Radiation machine source to image plane distance (mm).
>>Imaging Device-Specific Acquisition Parameters	(300A,00CC)	3	User-specified device-specific parameters which describe how the imager will acquire the image.

>>Referenced Reference Image Number	(300C,0007)	3	Uniquely identifies Reference Image to which planned verification image is related, specified by Reference Image Number (300A,00C8) within Referenced Reference Image Sequence (300A,0042).
>Treatment Delivery Type	(300A,00CE)	3	Delivery Type of treatment. Defined Terms: TREATMENT = normal patient treatment OPEN_PORTFILM = portal image acquisition with open field TRMT_PORTFILM = portal image acquisition with treatment port CONTINUATION = continuation of interrupted treatment
>Referenced Dose Sequence	(300C,0080)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Dose (for grids, isodose curves, and named/unnamed point doses). 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 Dose Sequence (300C,0080) is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Dose Sequence (300C,0080) is sent.
>Number of Wedges	(300A,00D0)	1	Number of wedges associated with current Beam.
>Wedge Sequence	(300A,00D1)	1C	Introduces sequence of treatment wedges. Required if Number of Wedges (300A,00D0) is non-zero. One or more items may be included in this sequence.
>>Wedge Number	(300A,00D2)	1C	Identification number of the Wedge. The value of Wedge Number (300A,00D2) shall be unique within the Beam in which it is created. Required if Wedge Sequence (300A,00D1) is sent.
>>Wedge Type	(300A,00D3)	2C	Type of wedge (if any) defined for Beam. Required if Wedge Sequence (300A,00D1) is sent. Defined Terms: STANDARD = standard (static) wedge DYNAMIC = moving beam limiting device (collimator) jaw simulating wedge MOTORIZED = single wedge which can be removed from beam remotely
>>Wedge ID	(300A,00D4)	3	User-supplied identifier for Wedge.
>>Wedge Angle	(300A,00D5)	2C	Nominal wedge angle (degrees). Required if Wedge Sequence (300A,00D1) is sent.
>>Wedge Factor	(300A,00D6)	2C	Nominal wedge factor under machine calibration conditions at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). Required if Wedge Sequence (300A,00D1) is sent.

>>Wedge Orientation	(300A,00D8)	2C	Orientation of wedge, i.e. orientation of IEC WEDGE FILTER coordinate system with respect to IEC BEAM LIMITING DEVICE coordinate system (degrees). Required if Wedge Sequence (300A,00D1) is sent.
>>Source to Wedge Tray Distance	(300A,00DA)	3	Radiation source to wedge tray attachment edge distance (in mm) for current wedge.
>Number of Compensators	(300A,00E0)	1	Number of compensators associated with current Beam.
>Total Compensator Tray Factor	(300A,00E2)	3	Compensator Tray transmission factor (between 0 and 1), at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111).
>Compensator Sequence	(300A,00E3)	1C	Introduces sequence of treatment compensators. Required if Number of Compensators (300A,00E0) is non-zero. One or more items may be included in this sequence.
>>Compensator Number	(300A,00E4)	1C	Identification number of the Compensator. The value of Compensator Number (300A,00E4) shall be unique within the Beam in which it is created. Required if Number of Compensators (300A,00E0) is non-zero.
>>Material ID	(300A,00E1)	2C	User-supplied identifier for material used to manufacture Compensator. Required if Number of Compensators (300A,00E0) is non-zero.
>>Compensator ID	(300A,00E5)	3	User-supplied identifier for compensator.
>>Source to Compensator Tray Distance	(300A,00E6)	2C	Radiation source to compensator tray attachment edge distance (in mm) for current compensator. Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Rows	(300A,00E7)	1C	Number of rows in the compensator. Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Columns	(300A,00E8)	1C	Number of columns in the compensator. Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Pixel Spacing	(300A,00E9)	1C	Physical distance (in millimetres) between the centre of each pixel projected onto machine isocentric plane. Specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing. Required if Compensator Sequence (300A,00E3) is sent.

>>Compensator Position	(300A,00EA)	1C	The x and y coordinates of the upper left-hand corner (first pixel transmitted) of the compensator, projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm). Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Transmission Data	(300A,00EB)	1C	A data stream of the pixel samples which comprise the compensator, expressed as broad-beam transmission values (between 0 and 1) along a ray line passing through the pixel, at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). The order of pixels sent is left to right, top to bottom (upper left pixel, followed by the remainder of row 1, followed by the remainder of the columns). Required if Compensator Sequence (300A,00E3) is sent and Material ID (300A,00E1) is zero-length.
>>Compensator Thickness Data	(300A,00EC)	1C	A data stream of the pixel samples which comprise the compensator, expressed as thicknesses (in millimetres) parallel to radiation beam axis. The order of pixels sent is left to right, top to bottom (upper left pixel, followed by the remainder of row 1, followed by the remainder of the columns). Required if Compensator Sequence (300A,00E3) is sent and Material ID (300A,00E1) is non-zero length.
>Number of Boli	(300A,00ED)	1	Number of boli associated with current Beam.
>Referenced Bolus Sequence	(300C,00B0)	1C	Introduces sequence of boli associated with Beam. Required if Number of Boli (300A,00ED) is non-zero. One or more items may be included in this sequence.
>>Referenced ROI Number	(3006,0084)	1C	Uniquely identifies ROI representing the Bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Referenced Bolus Sequence (300A,00B0) is sent.
>Number of Blocks	(300A,00F0)	1	Number of shielding blocks associated with Beam.
>Total Block Tray Factor	(300A,00F2)	3	Total block tray transmission for all block trays (between 0 and 1) at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111).

>Block Sequence	(300A,00F4)	1C	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. See C.8.X.14.4. 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)	2C	Physical thickness of block (in millimetres) parallel to radiation beam axis. Required if Block Sequence (300A,00F4) is sent and Material ID (300A,00E1) is non-zero length. See C.8.X.14.4.
>>Block Transmission	(300A,0102)	2C	Transmission through the block (between 0 and 1) at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). Required if Block Sequence (300A,00F4) is sent and Material ID (300A,00E1) is zero length. See C.8.X.14.4.
>>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. See Note 3.
>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.
>Final Cumulative Meterset Weight	(300A,010E)	1C	Value of Cumulative Meterset Weight (300A,0134) for final Control Point in Control Point Sequence (300A,0111). Required if Cumulative Meterset Weight is non-null in Control Points specified within Control Point Sequence (300A,0111). See C.8.X.14.1.
>Number of Control Points	(300A,0110)	1	Number of control points in Beam.
>Control Point Sequence	(300A,0111)	1	Introduces sequence of machine configurations describing treatment beam. Two or more items may be included in this sequence. See C.8.X.14.5 and C.8.X.14.6.
>>Control Point Index	(300A,0112)	1C	Index of current Control Point, starting at 0 for first Control Point. Required if Control Point Sequence (300A, 0111) is sent.

>>Cumulative Meterset Weight	(300A,0134)	2C	Cumulative weight to current control point. Cumulative Meterset Weight for the first item in Control Point Sequence shall always be zero. Cumulative Meterset Weight for the final item in Control Point Sequence shall always be equal to Final Cumulative Meterset Weight. Required if Control Point Sequence (300A, 0111) is sent. See C.8.X.14.1.
>>Referenced Dose Reference Sequence	(300C,0050)	3	Introduces a sequence of Dose References for current Beam. One or more items may be included in this sequence.
>>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module. Required if Referenced Dose Reference Sequence (300C,0050) is sent.
>>>Cumulative Dose Reference Coefficient	(300A,010C)	2C	Coefficient used to calculate cumulative dose contribution from this Beam to the referenced Dose Reference at the current Control Point. Required if Referenced Dose Reference Sequence (300C,0050) is sent. See C.8.X.14.7.
>>Nominal Beam Energy	(300A,0114)	3	Nominal Beam Energy at control point (MV/MeV).
>>Dose Rate Set	(300A,0115)	3	Dose Rate to be set on treatment machine for segment beginning at current control point (e.g. MU/min).
>>Wedge Position Sequence	(300A,0116)	3	Introduces sequence of Wedge positions for current control point. One or more items may be included in this sequence.
>>>Referenced Wedge Number	(300C,00C0)	1C	Uniquely references Wedge described by Wedge Number (300A,00D2) in Wedge Sequence (300A,00D1). Required if Wedge Position Sequence (300A,0116) is sent.
>>>Wedge Position	(300A,0118)	1C	Position of Wedge at current Control Point. Required if Wedge Position Sequence (300A,0116) is sent. Enumerated Values: IN, OUT.
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) positions. Required for first item of Control Point Sequence, or if Beam Limiting Device changes during Beam. One or more items may be included in this sequence.

>>>RT Beam Limiting Device Type	(300A,00B8)	1C	Type of beam limiting device (collimator). The value of this attribute shall correspond to RT Beam Limiting Device Type (300A,00B8) defined in an item of Beam Limiting Device Sequence (300A,00B6). Required if Beam Limiting Device Position Sequence (300A,0116) 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
>>>Leaf/Jaw Positions	(300A,011C)	1C	Positions of beam limiting device (collimator) leaf (element) or jaw pairs (in millimetres) 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 Beam Limiting Device Sequence (300A,00B6). Values shall be listed in IEC leaf (element) subscript order 101, 102, ... 1N, 201, 202, ... 2N. Required if Beam Limiting Device Position Sequence (300A,0116) is sent. See Note 2.
>>Gantry Angle	(300A,011E)	1C	Gantry angle of radiation source, i.e. orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first item of Control Point Sequence, or if Gantry Angle changes during Beam.
>>Gantry Rotation Direction	(300A,011F)	1C	Direction of Gantry Rotation when viewing gantry from isocenter, for segment following Control Point. Required for first item of Control Point Sequence, or if Gantry Rotation Direction changes during Beam. See C.8.X.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation

>>Beam Limiting Device Angle	(300A,0120)	1C	Beam Limiting Device angle, i.e. orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees). Required for first item of Control Point Sequence, or if Beam Limiting Device Angle changes during Beam.
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment following Control Point. Required for first item of Control Point Sequence, or if Beam Limiting Device Rotation Direction changes during Beam. See C.8.X.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation
>>Patient Support Angle	(300A,0122)	1C	Patient Support angle, i.e. orientation of IEC PATIENT SUPPORT (turntable) coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first item of Control Point Sequence, or if Patient Support Angle changes during Beam.
>>Patient Support Rotation Direction	(300A,0123)	1C	Direction of Patient Support Rotation when viewing table from above, for segment following Control Point. Required for first item of Control Point Sequence, or if Patient Support Rotation Direction changes during Beam. See C.8.X.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation
>>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)	1C	Table Top (non-isocentric) angle, i.e. orientation of IEC TABLE TOP ECCENTRIC coordinate system with respect to IEC PATIENT SUPPORT coordinate system (degrees). Required for first item of Control Point Sequence, or if Table Top Eccentric Angle changes during Beam.

>>Table Top Eccentric Rotation Direction	(300A,0126)	1C	Direction of Table Top Eccentric Rotation when viewing table from above, for segment following Control Point. Required for first item of Control Point Sequence, or if Table Top Eccentric Rotation Direction changes during Beam. See C.8.X.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation
>>Table Top Vertical Position	(300A,0128)	2C	Table Top Vertical position in IEC TABLE TOP coordinate system (mm). Required for first item of Control Point Sequence, or if Table Top Vertical Position changes during Beam. See C.8.X.14.6.
>>Table Top Longitudinal Position	(300A,0129)	2C	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm). Required for first item of Control Point Sequence, or if Table Top Longitudinal Position changes during Beam. See C.8.X.14.6.
>>Table Top Lateral Position	(300A,012A)	2C	Table Top Lateral position in IEC TABLE TOP coordinate system (mm). Required for first item of Control Point Sequence, or if Table Top Lateral Position changes during Beam. See C.8.X.14.6.
>>Isocenter Position	(300A,012C)	2C	Isocentre coordinates (x,y,z) in the patient based coordinate system described in C.7.6.2.1.1 (mm). Required for first item of Segment Control Point Sequence, or if Segment Isocentre Position changes during Beam.
>>Surface Entry Point	(300A,012E)	3	Patient surface entry point coordinates (x,y,z) in the patient-based coordinate system described in C.7.6.2.1.1 (mm).
>>Source to Surface Distance	(300A,0130)	3	Source to Patient Surface distance (mm).

NOTE 1 – The DICOM standard does not support the transmission of treatment unit modeling information such as depth doses and beam profiles.

NOTE 2 – Implementors should take note that Leaf Position Boundaries (300A,00BE) are the positions of the mechanical boundaries (projected to the isocentric plane) between beam limiting device (collimator) leaves, fixed for a given beam limiting device (collimator). Leaf/Jaw Positions (300A,011C) are values specific to a given beam control point, specifying the beam limiting device (collimator) leaf (element) openings.

NOTE 3 – Block coordinates may not be transmitted when such data is not available from the transmitting system. However, the receiving system may not have internal mechanisms to use or store such data. For example, a plan sent from an treatment planning system to a Record and Verify (R&V) system will contain the block data for blocked beams. Subsequent transfer of beam data from the R&V system may omit this data since the R&V system may not have stored it.

C.8.X.14.1 Meterset calculations

The Meterset at a given Control Point is equal to the Beam Meterset (300A,0086) specified in the Referenced Beam Sequence (300A,0004) of the RT Fraction Scheme Module, multiplied by the Cumulative Meterset Weight (300A,0134) for the Control Point, divided by the Final Cumulative Meterset Weight (300A,010E). The Meterset is specified in units defined by Primary Dosimeter Unit (300A,00B3). If the calculation for Meterset results in a meterset value which is not an exact multiple of the primary meterset resolution, then the result shall be rounded to the nearest allowed meterset value (i.e. less than a half resolution unit shall be rounded down to the nearest resolution unit, and equal or greater than half a resolution unit shall be rounded up to the nearest resolution unit).

Note also that if Final Cumulative Meterset Weight (300A,010E) is equal to 100, then Cumulative Meterset Weight (300A,0134) becomes equivalent to the percentage of Beam Meterset (300A,0086) delivered at each control point. If Final Cumulative Meterset Weight (300A,010E) is equal to Beam Meterset (300A,0086), then the Cumulative Meterset Weight (300A,0134) at each control point becomes equal to the cumulative Meterset delivered at that control point.

C.8.X.14.2 Planned Verification Image Sequence

The Planned Verification Image Sequence (300A,00CA) contains attributes which describe the planned verification images to be acquired during current beam. The Start Cumulative Meterset Weight (300C,0008) specifies the Cumulative Meterset Weight at which image acquisition is to begin. If Meterset Exposure (3002,0032) is present in a sequence item and End Cumulative Meterset Weight (300C,0009) is not present then a single image shall be acquired using the meterset duration specified in Meterset Exposure (3002,0032). If End Cumulative Meterset Weight (300C,0009) is present in a sequence item and Meterset Exposure (3002,0032) is not present then a single image shall be acquired over the beam delivery from Start Cumulative Meterset Weight (300C,0008) to End Cumulative Meterset Weight (300C,0009). If both Meterset Exposure (3002,0032) and End Cumulative Meterset Weight (300C,0009) are present in a sequence item then images shall be acquired every Meterset Exposure (3002,0032) from Start Cumulative Meterset Weight (300C,0008) to End Cumulative Meterset Weight (300C,0009). No images shall extend past End Cumulative Meterset Weight (300C,0009).

C.8.X.14.3 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.14.4 Multiple aperture blocks

All blocks with Block Type (300A,00F8) of APERTURE for a given beam shall have equal values of Block Transmission (300A,0102) and/or Block Thickness (300A,0100) if they are specified. The composite aperture shall be evaluated as the union of the individual apertures within a single Block. Shielding block transmission(s) shall be applied multiplicatively after the (composite) aperture has been evaluated.

C.8.X.14.5 Control Point Sequence

The DICOM RT Beams Module uses a single beam model to handle static, arc, and dynamic delivery of external beam radiation by a medical accelerator or gamma beam therapy equipment (cobalt unit). All applicable parameters shall be specified at Control Point 0, with the exception of couch positions (see C.8.X.14.6). All parameters which change at any control point of a given beam shall be specified explicitly at all control points (including those preceding the change). No assumptions are made about the behaviour of machine parameters between specified control points, and communicating devices shall agree on this behaviour outside the current standard. Some examples of beam specification using control points are as follows:

a) *Static delivery:*

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0

Control Point 1: Cumulative Meterset Weight = 1, no other parameters defined

b) *Arc delivery:*

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0, Gantry Rotation Direction = *rotation direction*, Gantry Angle = *initial angle*

Control Point 1: Cumulative Meterset Weight = 1, Gantry Rotation Direction = NONE, Gantry Angle = *final angle*

c) *Dynamic delivery of two equally weighted segments:*

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0

Control Point 1: All changing treatment parameters defined (including those which do not change at this control point), Cumulative Meterset Weight = 0.5

Control Point 2: All changing treatment parameters defined (including those which do not change at this control point), Cumulative Meterset Weight = 1

d) *Dynamic Delivery of two unequally weighted segments with a step change in table angle:*

Control Point 0: All applicable treatment parameters defined, Patient Support Angle = *initial angle*, Patient Support Rotation Direction = NONE, Cumulative Meterset Weight = 0

Control Point 1: Cumulative Meterset Weight = 0.3, Patient Support Angle = *initial angle*, Patient Support Rotation Direction = *rotation direction*, no other parameters defined

Control Point 2: Cumulative Meterset Weight = 0.3, Patient Support Angle = *new angle*, Patient Support Rotation Direction = NONE, no other parameters defined

Control Point 3: Cumulative Meterset Weight = 1, Patient Support Angle = *new angle*, Patient Support Rotation Direction = NONE, no other parameters defined

C.8.X.14.6 Absolute and relative machine coordinates

All treatment machine parameters except couch translations are specified in absolute machine coordinates as defined by IEC 61217. For the Table Top Vertical Position (300A,0128), Table Top Longitudinal Position (300A,0129), and Table Top Lateral Position (300A,012A), if the first Control Point contains a value of non-zero length, all subsequent Control Point position values are absolute values in their respective coordinate system. If the first Control Point contains a zero-length value, all subsequent Control Point position values are specified relative to the (unknown) initial value.

C.8.X.14.7 Cumulative Dose Reference Coefficient

The Cumulative Dose Reference Coefficient (300A,010C) is the value by which Beam Dose (300A,0084) is multiplied to obtain the dose to the referenced dose reference site at the current control point (and after previous control points have been successfully administered). The Cumulative Dose Reference Coefficient (300A,010C) is by definition zero for the initial control point. The Cumulative Dose Reference Coefficient (300A,010C) of the final control point multiplied by Beam Dose (300A,0084) results in the final dose to the referenced dose reference site for the current beam. Dose calculation for dose reference sites other than points is not well defined.

C.8.X.14.8 Machine rotations

For the machine rotation angles Gantry Angle (300A,011E), Beam Limiting Device Angle (300A,0120), Patient Support Angle (300A,0122) , and Table Top Eccentric Angle (300A,0125), rotation direction is specified as clockwise (CW), counter-clockwise (CC), or NONE. The maximum permitted rotation between two Control Points is 360 degrees. Examples:

a) Gantry Angle moves from 5 degrees to 5 degrees, Gantry Rotation Direction = NONE: No movement.

b) Gantry Angle moves from 5 degrees to 5 degrees, Gantry Rotation Direction = CW: Full clockwise rotation (360 degrees).

c) Table Angle moves from 170 degrees to 160 degrees, Table Rotation Direction = CC: Counter-clockwise rotation by 350 degrees (note direction of increasing table angle as defined by IEC 61217).

C.8.X.15 RT Brachy Application Setups Module

The RT Brachy Application Setups Module describes the application of a brachytherapy radiotherapy treatment. It contains one or more sources, each associated with one or more Channels. A Channel is a device by which a source is placed in its intended treatment position or positions. A Channel may consist of a Source Applicator plus a Transfer Tube, a Source Applicator alone, a rigid or flexible linear source, or a seed. A number of Channels (for example applicators, sources or seeds) are generally arranged in an Application Setup which may be considered a "logical" device. It is important not to confuse Application Setup with Applicator. The model used here has been primarily built around the concept of remote afterloading, but extended to support other brachytherapy applications such as manual applicators and molds, seeds, and sources. Additional devices which are not Channels are described as Brachy Accessory Devices. Examples of Accessory Devices include shields, which modify the dose distribution from all sources in the treatment. However, Channel shields modify the dose only for the source(s) in that Channel.

The data in the module are arranged as follows:

Treatment Machine Sequence	*;treatment machine information (single item)*
Source Sequence	*;library of sources used in brachy application*
Application Setup Sequence	*;one or more applicators, sources, seeds etc*
Brachy Accessory Device Sequence	*;application level shields, etc.*
Channel Sequence	*;applicator, line source(s), seed(s), etc.*
Channel Shield Sequence	*;channel-specific shields*
Brachy Control Point Sequence	*;mechanism to support individual source dwell times*

Table C.8.X.15-1 – RT Brachy Application Setups Module

Attribute Name	Tag	Type	Attribute Description
Brachy Treatment Technique	(300A,0200)	1	Type of brachytherapy treatment technique. Enumerated Values: INTRALUMENARY, INTRACAVITARY, INTERSTITIAL, CONTACT, INTRAVASCULAR, PERMANENT. See C.8.X.15.1.
Brachy Treatment Type	(300A,0202)	1	Type of brachytherapy treatment. Defined Terms: MANUAL = manually positioned HDR = High dose rate MDR = Medium dose rate LDR = Low dose rate PDR = Pulsed dose rate
Treatment Machine Sequence	(300A,0206)	1	Introduces single item sequence describing treatment machine to be used for treatment delivery. Only one item may be included in this sequence.
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine to be used for treatment delivery.
>Manufacturer	(0008,0070)	3	Manufacturer of the equipment to be used for treatment delivery.
>Institution Name	(0008,0080)	3	Institution where the equipment is located that is to be used for treatment delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that is to be used for treatment delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that is to be used for treatment delivery.
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that is to be used for treatment delivery.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that is to be used for treatment delivery.
Source Sequence	(300A,0210)	1	Introduces sequence of Sources to be used within Application Setups. One or more items may be included in this sequence.
>Source Number	(300A,0212)	1	Identification number of the Source. The value of Source Number (300A,0212) shall be unique within the RT Plan in which it is created.
>Source Type	(300A,0214)	1	Type of Source. Defined Terms: POINT, LINE, CYLINDER, SPHERE.
>Source Manufacturer	(300A,0216)	3	Manufacturer of Source.
>Active Source Diameter	(300A,0218)	3	Diameter of active Source (mm).
>Active Source Length	(300A,021A)	3	Length of active Source (mm).
>Material ID	(300A,00E1)	3	User-supplied identifier for encapsulation material of active Source.
>Source Encapsulation Nominal Thickness	(300A,0222)	3	Nominal thickness of wall of encapsulation (mm).

>Source Encapsulation Nominal Transmission	(300A,0224)	3	Nominal transmission through wall of encapsulation (between 0 and 1).
>Source Isotope Name	(300A,0226)	1	Name of Isotope.
>Source Isotope Half Life	(300A,0228)	1	Half-life of Isotope (days).
>Reference Air Kerma Rate	(300A,022A)	1	Air Kerma Rate in air of Isotope specified at Air Kerma Rate Reference Date (300A,022C) and Air Kerma Rate Reference Time (300A,022E) (in µGy h^{-1} at 1 m).
>Air Kerma Rate Reference Date	(300A,022C)	1	Reference date of Reference Air Kerma Rate (300A,022A) of Isotope.
>Air Kerma Rate Reference Time	(300A,022E)	1	Reference time of Air Kerma Rate (300A,022A) of Isotope.
Application Setup Sequence	(300A,0230)	1	Introduces sequence of Application Setups for current RT Plan. One or more items may be included in this sequence.
>Application Setup Type	(300A,0232)	1	Type of Application Setup. Defined Terms: FLETCHER_SUIT, DELCLOS, BLOEDORN, JOSLIN_FLYNN, CHANDIGARH, MANCHESTER, HENSCHKE, NASOPHARYNGEAL, OESOPHAGEAL, ENDOBRONCHIAL, SYED_NEBLETT, ENDORECTAL, PERINEAL.
>Application Setup Number	(300A,0234)	1	Identification number of the Application Setup. The value of Application Setup Number (300A,0234) shall be unique within the RT Plan in which it is created.
>Application Setup Name	(300A,0236)	3	User-defined name for Application Setup.
>Application Setup Manufacturer	(300A,0238)	3	Manufacturer of Application Setup.
>Template Number	(300A,0240)	3	Identification number of the Template. The value of Template Number (300A,0240) shall be unique within the Application Setup in which it is created.
>Template Type	(300A,0242)	3	User-defined type for Template Device.
>Template Name	(300A,0244)	3	User-defined name for Template Device.
>Referenced Reference Image Sequence	(300C,0042)	3	Introduces sequence of reference images used for validation of current Application Setup. 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 Reference Image Sequence (300C,0042) is sent.
>>Referenced SOP Class Instance	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Reference Image Sequence (300C,0042) is sent.
>Total Reference Air Kerma	(300A,0250)	1	Total Reference Air Kerma for current Application Setup, i.e. the product of Air Kerma Rate of all Sources in all Channels with their respective Channel Times (µGy at 1 m).

>Brachy Accessory Device Sequence	(300A,0260)	3	Introduces sequence of Brachy Accessory Devices associated with current Application Setup. One or more items may be included in this sequence.
>>Brachy Accessory Device Number	(300A,0262)	2C	Identification number of the Brachy Accessory Device. The value of Brachy Accessory Device Number (300A,0262) shall be unique within the Application Setup in which it is created. Required if Brachy Accessory Device Sequence (300A,0260) is sent.
>>Brachy Accessory Device ID	(300A,0263)	2C	User or machine supplied identifier for Brachy Accessory Device. Required if Brachy Accessory Device Sequence (300A,0260) is sent.
>>Brachy Accessory Device Type	(300A,0264)	1C	Type of Brachy Accessory Device. Required if Brachy Accessory Device Sequence (300A,0260) is sent. Defined Terms: SHIELD, DILATATION, MOLD, PLAQUE, FLAB.
>>Brachy Accessory Device Name	(300A,0266)	3	User-defined name for Brachy Accessory Device.
>>Material ID	(300A,00E1)	3	User-supplied identifier for material of Brachy Accessory Device. See Note 1.
>> Brachy Accessory Device Nominal Thickness	(300A,026A)	3	Nominal thickness of Brachy Accessory Device (mm).
>> Brachy Accessory Device Nominal Transmission	(300A,026C)	3	Nominal Transmission through Brachy Accessory Device (between 0 and 1).
>>Referenced ROI Number	(3006,0084)	2C	Uniquely identifies ROI representing the Brachy Accessory specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by Referenced RT Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Brachy Accessory Device Sequence (300A,0260) is sent. See C.8.X.15.2.
>Channel Sequence	(300A,0280)	1	Introduces sequence of Channels for current Application Setup. One or more items may be included in this sequence.
>>Channel Number	(300A,0282)	1	Identification number of the Channel. The value of Channel Number (300A,0282) shall be unique within the Application Setup in which it is created.
>>Channel Length	(300A,0284)	2	Length of Channel (mm). See C.8.X.15.3.