Digital Imaging and Communications in Medicine (DICOM)

Supplement 199: Second Generation Radiotherapy –

RT Radiation Records

DICOM Standards Committee, Working Group 7, Radiation Therapy

1300 N. 17th Street, Suite 900

Rosslyn, Virginia 22209 USA

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Open Issues and Discussion Points

#	Item
22	Should overrides not only be issued by persons, but also by devices? Within the Override Sequence (3008,0060), there is the Operator Identification Sequence (0008,1072). The question was raised as to whether this sequence should not be restricted to the Person Identifier Macro Attributes (Table 10-1) but should be the Identified Person or Device Macro (Table C.17-3b).
26	Are the parameters in C.36.m3 RT Radiation Record Common Module available for a Manual Radiation Record? Or should the attributes in this Module be sorted out for manual/system-recorded RT Radiation Record instances? Or should it be made type U?
27	Do we need coded Override Reasons? What would they be and how would they be used?

2

Closed Issues

#	Item
1	How to capture the high-frequency recordings of machine parameters. E.g. dynamic MLC Control Points may be in the range of 300, but recordings could easily be in a range increased by factor 10 or more. Yet those high-frequency recordings are pretty important for QA and eventually dose recalculation purposes. Specifically, we need to have a look at the high-frequency recording issue (below the Control Point level). How to capture the large volume of dynamic machine logging information? If high-frequency recording is not needed for routine QA, this data need not be stored in the Radiation Record. DICOM Raw Data Storage could be used to encapsulate dynamic log files. Majority tendency is to store high-frequency QA data using DICOM Raw Data Storage (as encapsulated proprietary machine format). Minority opinion supports inclusion of this information within the Radiation Record IOD (using standard encoding). WG-07 Jan 2018: Shortly discussed. Certainly, encapsulating it as a separate IOD is preferred, since it avoids that Treatment Records gets very large for every application, though the high-frequency data may not be of interest. 2019-07-15 Ulrich Busch: Added Additional Parameter Recording Instance Sequence (gggg,7580) and C.36.m3.3.1.3. Ready for final Review. 2019-07-31 WG-07: Reviewed and approved..
2	The Frame of References to be used in the Radiation Record IODs is the one of the current treatment session. It would be useful to find a way to describe the use of frame of reference in the context of these IODs. Also: Frame of Reference – image vs. device. 2019-07-22 Ulrich Busch: Added section A.86.1.a3.4.5 and referenced this section in other IODs. The relation of the Frame of Reference to image versus device is generall describe in C.7.4.1 and specifically for Radiotherapy in 10.39.1. Both sections are referenced. Wording could like be revised. Otherwise ready for final Review. 2019-07-31 WG-07: Reviewed, revised and closed.

3	Compensator – detailed specification compensator (e.g., map) is not known to recording device Blocks – detailed specification, e.g., divergence, aperture is not known to recording device. 2017-12-07 U. Busch: Discussed and worked out WG-07 Meeting June 2017. Approach is to specify those attributes, which may not be recorded as conditional with a requirement along the following outline: Required if RT Radiation Content Type (gggg,5013) equals VOLUMETRIC.
4	Target coordinates (robotic) 2019-07-15 Ulrich Busch: Question was whether they are they recordable? The Issue referred to RT Treatment Target Coordinates (30xx,9F44) in earlier versions of Sup 176. However, this Attributes was removed in May 2018 and therefore the Issue can be closed. 2019-07-24: Bob Pekarek will double-check, whether Target Coordinates are of interest in the RT Radiation (Sup 176) and/or RT Radiation Record (Sup 199) 2019-07-31 WG-07: Along Bob, target coordinates are not needed in the RT Radiation, therefore also no issue for recording.
5	Some Multisource delivery devices have manually configured “helmets” whose configuration cannot be automatically recorded. 2019-07-15 Ulrich Busch: This is important to be sorted out in Supplement 176. The latest version does not contain any conditions as used in several Macro (Blocks, Compensators etc.) worded as: “Required if RT Radiation Physical and Geometric Content Detail Flag (gggg,5013) equals FULL. May be present otherwise.” In absence of such condition, a record for the multisource delivery device MUST contain all Attributes describing Collimator angle and positions, Collimator groups and the patterns used etc. . Sequences containing those items have multiplicity one or more, so there must be Items included. If the original input above is true, treatments with manually configured “helmets” cannot be recorded. Recording of fake values is not acceptable. Currently it is doubtful whether this has been considered properly. 2019-07-24 Ulrich Busch: As clarified by Jim Percy, there is no need to cover those systems will by 2nd Generation.
6	Rename all CIDs to give the numbers a local scope, as done in 175, 176, 177 (CID SUP147mmm -> CID SUP199nnn). 2017-06-19 U. Busch: Done
7	IEC 60601-2-1 Edition 4: Clause 201.107 contains requirements for recording. All can be met, besides: - INTERLOCK information, error codes or messages generated during TREATMENT and time stamp when they occurred. 2019-07-15 Ulrich Busch: Added Interlock Signal Sequence (gggg,7540) to cover this requirement. All attributes and esp. their types should be reviewed. CID SUP199004 should be reviewed. Is the initial code set well-defined and could be other codes added right away? Afterwards ready for final Review. 2019-07-31 WG-07: Approach approved.
8	2017-12-07 U. Busch: Added new IOD: Manual RT Radiation Record IOD Description. This IOD should allow to manual record treatments, where details may not be known and/or the application providing manual recording features cannot construct the native device-specific modules.

	To be discussed and reviewed and decided upon. 2019-07-15 Ulrich Busch: Concept and use cases have been presented at two F2F Meetings in the past. Section A.86.1.a2.1 Manual RT Radiation Record IOD Description contains the role of this IOD. Text completely revised. Review of this section is indicated (including review of section C.36.m4 Manual RT Radiation Record Module). Ready for final Review (esp. incl. parameter sequence) 2019-07-30 WHG-07: reviewed and closed
9	2017-05-19: Define Fx Indexing as appropriate for adaptive treatments: In case of adaptive treatments the referenced Radiation Set may change due to adaptation at each treatment session. In a strict sense this means, that each time the referenced Radiation Set changes the fraction number re-starts with 1. However, this does not represent the clinical perception. Therefore, the Fraction Number attribute(s) should take this into account. Ideally bind it to the prescription, if present. 2019-07-15 Ulrich Busch: Replaced the single Current Fraction Number Attribute by two Attributes serving specific scopes. See section C.36.m1.1.2 and related Attributes. To be reviewed. 2019-08-01 Bob Pekarek: Updated section to include Clinical Fraction Number, RT Radiation Set Delivery Number, and corresponding text.
10	Do we want to offer a Recording IOD for treatment modalities, which are not yet represented in 2nd Gen (with modality-specific Radiation IODs). I.e. a generic recoding facility? Would be similar to Manual RT Radiation Record IOD? In total we would have the following 3 recording types: 1. Modality-aware full record (e.g. C-Arm Radiation record) - written by machine - written by manual recording 2. Manual RT Radiation Record - referencing the 2nd Gen Radiation IODs, but not containing modality-specific content 3. Manual Record without DICOM representation of a Radiation IOD (‘plan’) - Not referencing any Radiation IODs. (not yet finally approved to go for) 2019-07-15 Ulrich Busch: Propose to drop this idea: It is questionable how recording can be used downstream if there is not any representation of an RT Radiation Set and RT Radiations, which provide the hook to accumulate treatment fractions. Such an approach can still be added later in case there is useful application. Then the only question at this time is whether the Modules used by the Manual RT Radiation Record IOD could be prepared for re-use in such a concept in future. However, also the manual recording IOD assumes references to RT Radiation Set and RT Radiations in such important roles, that a re-use (with conditions, etc. and which ones…?) would undermine the stability and clarity of this IOD. Therefore, at this time we should drop this idea. Ready for final decision. 2019-07-31 WG-07: We will not integrate this idea into the IODs and Modules of this Supplement. In case there is real interest, we would make up a separate IOD which certainly has different characteristics in many aspects.
11	2018-10-25 U. Busch, based on WG-07 discussions: Removed requirement, that gggg,5013 needs to be NONE.
12	Synchronization UID is gone from Device Common Module. We something like this for the Records. Full Module or only UID or otherwise?

	2019-07-15 Ulrich Busch: Specification of Synchronization is sufficiently important for dynamic treatment aspects. Namely when acquired images and waveform are related to records, it should be known whether their timestamps are synchronized or not. Therefore: - added Module Synchronization C.7.4.2 to all but Manual RT Radiation Record IOD (where this is of no use). - extended existing section C.7.4.2.1.4 Acquisition Time Synchronized to specify the Attributes to whom the switch of this Attributes applies to (in the same sense as done for the SR documents). Ready for final Review. 2019-07-31 WG-07: OK to have it included. See comment in Tomo IOD: May be proposed to other IODs as well.
13	Adapt to follow: Sup 175 R72 Renaming of (gggg,5013) and related Enumerated Values. 2019-07-15 Ulrich Busch: Added Attributes - RT Radiation Physical and Geometric Content Detail Flag (gggg,5013) - RT Record Flag (300A,0639) containing only one enumerated value. This completes the approach, that these Attributes are used in various Macros to switch on and off the requirement to have values present. These requirements depend on whether the Macro is invoked in an RT Radiation IOD or in an RT Radiation record IOD. For records the values must be only the ones which are now being soley enumerated in the Attributes above. Ready for final Review (specification-technical focus – no semantic discussion expected). 2019-07-31 WG-07: Decision to re-introduce YES/NO to RT Record Flag (300A,0639) and do it as in Sup 175 (not yet done).
14	2019-07-15 Ulrich Busch: Review revised text of A.86.1.a3.1 Tomotherapeutic Radiation Record IOD Description, considering the text as boiler plate text for all IODs and in a slightly modified form for A.86.1.a2.1 Manual RT Radiation Record IOD Description as well. Ready for final Review. 2019-07-31 WG-07: Revised and approved. TODO for all IODs
15	Add a section to explain the role of the Referenced Defined Device Index (300A,0602) used in the device Macros. 2019-07-30: Added C.36.2.2.8.1.5 Referenced Defined Device Index, reviewed with WG-07.
16	2019-07-31 WG-07: Each RT Radiation Record SOP Instance is only referenced by exactly RT Radiation Record Set SOP Instance. A reference from RT Radiation Record SOP Instance to RT Radiation Record Set SOP Instance could solve this (but in general bi-directional references should be avoided). Add text to indicate only one RT Radiation Record Set may contain any single RT Radiation Record instance. C.36.m1.1.1 updated to state that (see previous statement).
17	2019-07-31 WG-07: Referenced RT Radiation Set Sequence (gggg,7502): The use cases, when a Radiation Set Instance in not present, should be identified and documented to help implementors to identify when this setting is appropriate. 2019-08-01 Use 1C as Type.
18	2019-07-31 WG-07:

	Fraction Completion Status (gggg,7506) (or similar): Value of such summary status is, that it shall allow a system looking at the treatment status to know, whether treatment proceeds regularly of there are expectation to be assessed. It shall be possible to see at a Radiation Record Set level, that a fraction has been delivered completely, so that it is not needed to dig into details of the Radiation Records to find out. This is the 99% case. Anything else may be represented by just the opposite flag or by more detailed characteristics of the presence of exceptional circumstances. There are multiple dimensions which could be represented. Current attribute definition is an intermediate state at the end of the discussion. The group voted to use the Attribute name of RT Radiation Set Completion Status. It is a type 1. It provides a status that indicates if the RT Radiation Set was completely delivered. Enumerated values include YES and NO.
19	Discuss with Uli on the Purpose of the Alternate Specified Value Sequence (gggg,753E) and its semantic meaning. 8/22/2019 Still needs clarification. 8/27/2019 Accepted as written.
20	For public comment: what additional Context items should be included in CID SUP199005 “Treatment Session Sign-Off Assertions”? 11/22/2019 WG7 face to Face Melbourne OK with the two listed for Bolus and Cone
21	For public comment: what additional Context items should be included in CID SUP199007 “Treatment Parameter Override Reasons”? 11/22/2019 WG7 face to Face Melbourne added Delivery Rate and Tolerance- should be good to go now

Scope and Field of Application

This Supplement defines several IODs for RT Radiation Records based on the real-world model and specifications defined in Supplement 147. References, definitions etc. not present in this Supplement can be found in the DICOM Standard and Supplement 176.

The SOP Classes in this document are defined to record how a treatment was performed. This comprises acquired machine values, measured dose values, overrides, etc. In addition, recording of a manual implementation of a Radiation is covered.

Part 2 Addendum

Add new SOP Classes to PS3.2 Table A.1-2 UID Values:

UID Value	UID Name	Category
1.2.840.10008.5.1.4.1.1.481.XN.6.1	RT Radiation Record Set Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.XN.6.2	Manual Radiation Record Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.XN.6.3	Tomotherapeutic Radiation Record Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.XN.6.4	C-Arm Photon Electron Radiation Record Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.XN.6.6	Robotic-Arm Radiation Record Storage	Transfer

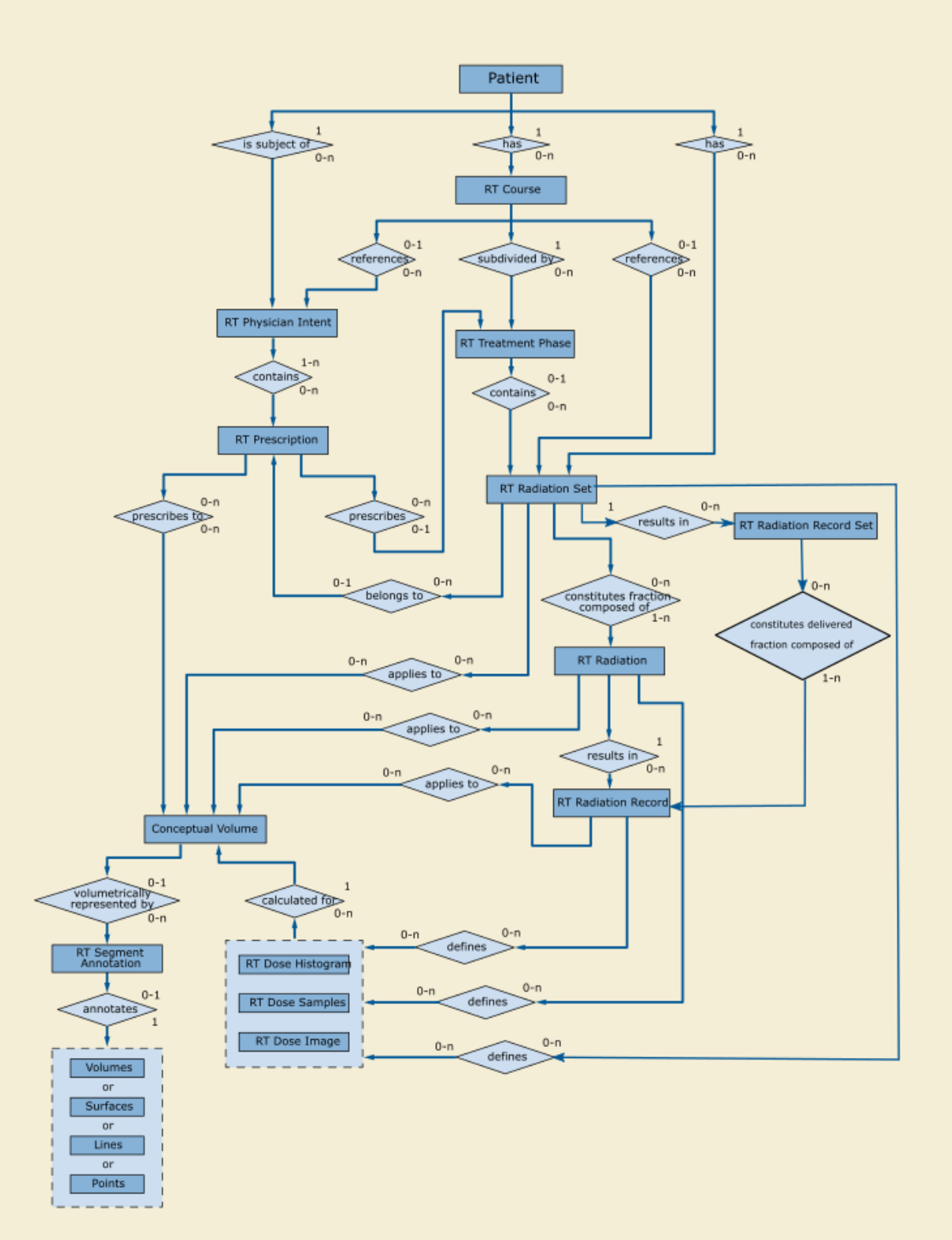
Part 3 Addendum

Add the following in PS3.3 Chapter 7 DICOM model of the real-world

7.14 EXTENSION OF THE DICOM MODEL OF THE REAL-WORLD FOR RADIOTHERAPY SECOND GENERATION INFORMATION OBJECTS

For the purpose of RT Second Generation SOP Classes the DICOM Model of the Real-World is described in this section. This subset of the real-world model covers the requirements for transferring information about planned and performed radiotherapeutic treatments and associated data.

Figure 7.14-1 describes the most important elements involved in the radiotherapy domain in DICOM.



Note 1: IODs which contain a representation of Volumes, Surfaces, Lines, Points can be annotated by an RT Segment Annotation.

Note 2: For better readability the diagram only contains the most important relationships, e.g. all objects have a relation to the Patient, but not all of these relationships are part of this diagram.

Figure 7.14-1 DICOM MODEL OF THE REAL WORLD – RADIOTHERAPY

Add the following columns in PS3.3 Section A.1.4, Table A.1-1 COMPOSITE INFORMATION OBJECT MODULES OVERVIEW – RADIOTHERAPY

IODs Modules	RT Radiation Record Set	Manual Rec	C-Arm Photon-Electron Rec	Tomo Rec	Rob Rec
Patient	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U
General Study	M	M	M	M	M
Patient Study	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U
General Series	M	M	M	M	M
Clinical Trial Series	U	U	U	U	U
Enhanced RT Series	M	M	M	M	M
General Equipment	M	M	M	M	M
Enhanced General Equipment	M	M	M	M	M
Frame Of Reference	M	M	M	M	M
Synchronization			C	C	C
…					
General Reference Module	M	M	M	M	M
…					
RT Radiation Record Set	M				
RT Dose Contribution Record	M				
RT Delivery Device Common		M	M	M	M
RT Radiation Record Common		M	M	M	M
RT Radiation Common		M	M	M	M
Manual Radiation Record		M			
C-Arm Photon-Electron Delivery Device			M		
C-Arm Photon-Electron Beam			M		

IODs Modules	RT Radiation Record Set	Manual Rec	C-Arm Photon-Electron Rec	Tomo Rec	Rob Rec
Tomotherapeutic Delivery Device				**M**	
Tomotherapeutic Beam				**M**	
Robotic-Arm Delivery Device					**M**
Robotic-Arm Path					**M**
...					
Common Instance Reference Module	**M**	**M**	**M**	**M**	**M**
Radiotherapy Common Instance	**M**	**M**	**M**	**M**	**M**
SOP Common	**M**	**M**	**M**	**M**	**M**

Add the following to PS3.3 Annex A:

A.86 SECOND GENERATION RADIATION THERAPY

A.86.1 RT Second Generation Objects

…

A.86.1.1 RT Second Generation Common Information

…

A.86.1.1.1 Second Generation Radiation Therapy Entity-Relationship Model

…

Replace Figure A.86.1.1.1-1 in PS3.3 Annex A with the following

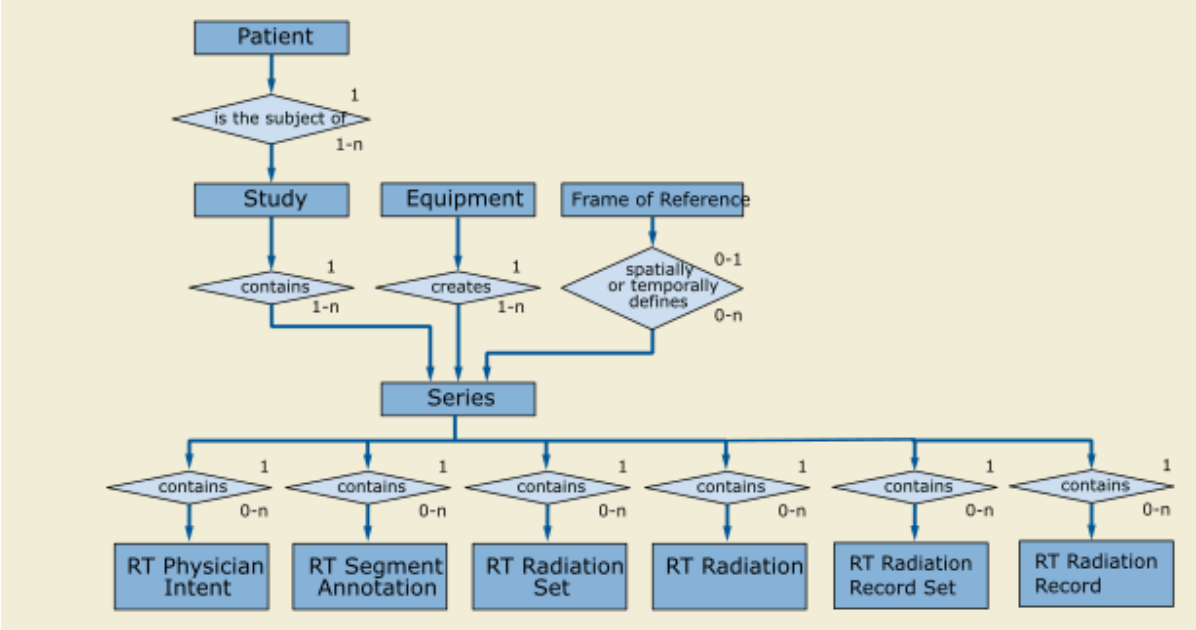


Figure A.86.1.1.1-1 — RT Second Generation IOD information model

Add the following to PS3.3 Annex A:

A.86.1.a1 RT Radiation Record Set Information Object Definition

The RT Radiation Record Set IOD contains the record of a radiotherapy treatment that has been performed based on an RT Radiation Set SOP Instance.

A.86.1.a1.1 RT Radiation Record Set IOD Description

A.86.1.a1.2 RT Radiation Record Set IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.a1.3 RT Radiation Record Set IOD Module Table

Table A.86.1.a1-1
RT Radiation Record Set IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
RT Treated Radiation	General Reference	C.12.4	M
	RT Radiation Record Set Common	C.36.m1	M
	RT Dose Contribution Record	C.36.m2	C - Required if the dose delivered is tracked.
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.a2 Manual Radiation Record Information Object Definition

A.86.1.a2.1 Manual Radiation Record IOD Description

The Manual Radiation Record IOD contains the manually captured record of a complete or partial fraction of therapeutic radiation delivered using any therapeutic device.

A device usually creates RT Radiation Record SOP Instances using modality-specific RT Radiation Record IODs and transfers these Instances to a system that captures treatment records. If this process fails (e.g. because of failed transfer operations) and the recorded SOP Instances are not recoverable from the device, the radiation delivery is captured by manual entry. Systems providing manual entry capabilities might not be able to create a modality-specific RT Radiation Record SOP Instance covering all device-specific parameters in question and/or the user might not know all the details. Therefore, the modality-specific RT Radiation Record IODs cannot be properly populated. The Manual Radiation Record IOD allows these manual entries to be recorded.

A.86.1.a2.2 Manual Radiation Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.a2.3 Manual Radiation Record IOD Module Table

Table A.86.1.a2-1
Manual Radiation Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	U
RT Treated Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	U
	RT Radiation Record Common	C.36.m3	M
	Manual Radiation Record Module	C.36.m4	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.a2.4 Manual Radiation Record IOD Constraints

A.86.1.a2.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.a2.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall have the value used by the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	Defined CID shall be the CID specified for the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.

A.86.1.a2.4.3 RT Radiation Record Common Module

The value of RT Record Flag (gggg,5014) shall be YES.

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	Defined CID shall be the CID specified for the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.
Treatment Machine Special Mode Sequence (300A,0635)	Defined CID shall be the CID specified for the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.

A.86.1.a2.4.4 Radiotherapy Common Instance Module

Code Sequence	CID
Author Identification Sequence (3010,0019)	Defined CID for Organizational Role Code Sequence (0044,010A) is CID SUP199002 “Radiotherapy Treatment Delivery Person Roles”

A.86.1.a2.4.5 Frame of Reference Module

The Frame of Reference UID (0020,0052) identifies the patient-based Frame of Reference while the therapeutic radiation was delivered. The Frame of Reference UID relates the geometric parameters of this SOP Instance to other SOP Instances such as Images, Segmentations, etc. If the patient moves with respect to the patient positioning device between the delivery recorded by the current SOP Instance and another SOP Instance, a new Frame of Reference UID shall be issued. See also C.7.4.1.

The relationship between the patient-oriented coordinate system identified by this Frame of Reference and the Equipment Coordinate System is described in 10.39.1.

A.86.1.a3 Tomotherapeutic Radiation Record Information Object Definition

A.86.1.a3.1 Tomotherapeutic Radiation Record IOD Description

The Tomotherapeutic Radiation Record IOD contains the record of a radiotherapy treatment that has been performed using a Tomotherapeutic Radiation SOP Instance.

A.86.1.a3.2 Tomotherapeutic Radiation Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.a3.3 Tomotherapeutic Radiation Record IOD Module Table

Table A.86.1.a3-1
Tomotherapeutic Radiation Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied
RT Treated Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Record Common	C.36.m3	M
	Tomotherapeutic Delivery Device	C.36.F1	M
	Tomotherapeutic Beam	C.36.F2	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.a3.4 Tomotherapeutic Radiation Record IOD Constraints

A.86.1.a3.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.a3.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4.3.1, which identifies the IEC 61217 Fixed Coordinate System Frame of Reference, see C.36.12.2.1.

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	Defined CID SUP176006 “Tomotherapeutic Dosimeter Unit Definition”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, “Nominal Radiation Source Location”).

A.86.1.a3.4.3 RT Radiation Record Common Module

The value of RT Record Flag (gggg,5014) shall be YES. The value of RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals IDENT_ONLY.

The following code sequences shall have a value from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	Defined CID 9512 “Tomotherapeutic Radiotherapy Procedure Techniques”
Treatment Machine Special Mode Sequence (300A,0635)	Defined CID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.a3.4.4 Radiotherapy Common Instance Module

Code Sequence	CID
Author Identification Sequence (3010,0019)	Defined CID for Organizational Role Code Sequence (0044,010A) is CID SUP199002 “Radiotherapy Treatment Delivery Person Roles”

A.86.1.a3.4.5 Frame of Reference Module

See A.86.1.a2.4.5.

A.86.1.a4 C-Arm Photon-Electron Radiation Record Information Object Definition

A.86.1.a4.1 C-Arm Photon-Electron Radiation Record IOD Description

The C-Arm Photon-Electron Radiation Record IOD contains the record of a radiotherapy treatment that has been performed using a C-Arm Photon-Electron Radiation SOP Instance.

A.86.1.a4.2 C-Arm Photon-Electron Radiation Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.a4.3 C-Arm Photon-Electron Radiation Record IOD Module Table

Table A.86.1.x4-1
C-Arm Photon-Electron Radiation Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied
	General Reference	C.12.4	M

RT Treated Radiation	RT Delivery Device Common	C.36.12	M
	RT Radiation Record Common	C.36.m3	M
	C-Arm Photon-Electron Delivery Device	C.36.14	M
	C-Arm Photon-Electron Beam	C.36.15	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.a4.4 C-Arm Photon-Electron Radiation Record IOD Constraints

A.86.1.a4.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.a4.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4.3.1, which identifies the IEC 61217 Fixed Coordinate System Frame of Reference, see C.36.12.2.1.

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	Defined CID 9552 “C-Arm Photon-Electron Dosimeter Unit”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, “Nominal Radiation Source Location”).

A.86.1.a4.4.3 RT Radiation Record Common Module

The value of RT Record Flag (gggg,5014) shall be YES. The value of RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals IDENT_ONLY.

The following code sequences shall have a value from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	Defined CID 9511 “General External Radiotherapy Procedure Techniques”
Treatment Machine Special Mode Sequence (300A,0635)	Defined CID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.a4.4.4 Radiotherapy Common Instance Module

Code Sequence	CID
Author Identification Sequence (3010,0019)	Defined CID for Organizational Role Code Sequence (0044,010A)is CID SUP199002

	"Radiotherapy Treatment Delivery Person Roles"

A.86.1.a4.4.5 Frame of Reference Module

See A.86.1.a2.4.5.

A.86.1.a6 Robotic-Arm Radiation Record Information Object Definition

A.86.1.a6.1 Robotic-Arm, Radiation Record IOD Description

The Robotic-Arm Radiation Record IOD contains the record of a radiotherapy treatment that has been performed using a Robotic-Arm Radiation SOP Instance.

A.86.1.a6.2 Robotic-Arm Radiation Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.a6.3 Robotic-Arm Radiation Record IOD Module Table

Table A.86.1.a6-1
Robotic-Arm Radiation Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied
RT Treated Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Record Common	C.36.m3	M
	Robotic-Arm Delivery Device	C.36.J1	M
	Robotic-Arm Path	C.36.J2	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.a6.4 Robotic-Arm Radiation Record IOD Constraints

A.86.1.a6.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.a6.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4.RRR.4, which identifies the Standard Robotic-Arm Coordinate System Frame of Reference, see C.36.12.2.N3.

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	Defined CID SUP176008 “Robotic RT Therapy Dosimeter Unit Definition”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, “Nominal Radiation Source Location”).

A.86.1.a6.4.3 RT Radiation Record Common Module

The value of RT Record Flag (gggg,5014) shall be YES. The value of RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals IDENT_ONLY.

The following code sequences shall have a value from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	Defined CID 9523 “Robotic Radiation Technique”
Treatment Machine Special Mode Sequence (300A,0635)	Defined CID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.a6.4.4 Radiotherapy Common Instance Module

Code Sequence	CID
Author Identification Sequence (3010,0019)	Defined CID for Organizational Role Code Sequence (0044,010A)is CID SUP199002 “Radiotherapy Treatment Delivery Person Roles”

A.86.1.a6.4.5 Frame of Reference Module

See A.86.1.a2.4.5.

Append the following in PS3.3 Annex C:

C.7.4.2.1.4 Acquisition Time Synchronized

The Acquisition Time Synchronized (0018,1800) Attribute specifies whether Acquisition DateTime (0008,002A) of the Waveform Identification Module or the General Image Module represents an accurate synchronized timestamp for the acquisition of the waveform and/or image data. For triggered multi-frame images, the Acquisition DateTime applies to the trigger for the first image frame (see Attribute Image Trigger Delay (0018.1067) in the Cine Module).

Note The degree of precision of the Acquisition DateTime and its accuracy relative to the external clock are not specified, but need to be appropriate for the clinical application.

For IODs that include the SR Document Content Module, the Acquisition Time Synchronized (0018,1800) Attribute specifies whether Observation DateTime (0040,A032) of Items in Content Sequence (0040,A730) of the SR Document Content Module represents an accurate synchronized timestamp for the Item.

For IODs that include the RT Radiation Record Common Module, the Acquisition Time Synchronized (0018,1800) Attribute specifies whether the following Attributes represent a synchronized timestamp.

- Recorded RT Control Point DateTime (gggg,753A)

- Interlock DateTime (gggg,7541)

Add the following section to PS3.3 Annex C, section C.36.2.2.8.1:

C.36.2.2.8.1.5 Referenced Defined Device Index

The Referenced Defined Device Index (300A,0602) provides the facility to relate devices from one Instance to the other. Device Macros such as the RT Beam Limiting Device Definition Macro are used in Sequences which list the devices used in the context of a SOP Instance. Each device is identified by the Device Index (3010,0039). These Sequences may be present in other related SOP Instances.

For example, an RT Radiation Instance may contain the RT Beam Limiting Device Definition Sequence (300A,064D), listing the Beam Limiting Devices to be used for treatment. A related RT Radiation Record Instance for the same type of delivery device will contain the same Sequences. However, the collection of devices used may not be the same:

E.g., the RT Radiation Instance may describe a treatment that contains three Items with the following indices:

- Device Index = 1: Type (130331, DCM, “Leaf Pairs”) with one leaf pair and the orientation (130334, DCM, “X Orientation”), representing X-Jaws
- Device Index = 2: Type (130331, DCM, “Leaf Pairs”) with one leaf pair and the orientation (130335, DCM, “Y Orientation”), representing Y-Jaws
- Device Index = 3: Type (130331, DCM, “Leaf Pairs”) with 80 leaf pairs and the orientation (130334, DCM, “X Orientation”), representing an X-MLC

However, the treatment may have been executed on a different machine which has the X-Jaws and the X-MLC, but a fixed collimator in the Y direction instead of the Y-Jaws. Therefore, the Y-Jaws will

not be recorded as they have not been used. Also the fixed collimator in Y direction is not recorded, as this is not a device which is part of the RT Beam Limiting Device Definition Sequence (300A,064D). The Referenced Defined Device Index (300A,0602) will then point to the indices in the referenced RT Radiation Instance to annotate which device in the RT Radition Record corresponds to the device in the RT Radiation. In this case, the RT Radiation Record would contain the devices as listed in the following:

- Device Index = 1: Type (130331, DCM, “Leaf Pairs”) with one leaf pair and the orientation (130334, DCM, “X Orientation”), representing X-Jaws
  -> Referenced Defined Device Index = 1

- Device Index = 2: Type (130331, DCM, “Leaf Pairs”) with 80 leaf pairs and the orientation (130334, DCM, “X Orientation”), representing an X-MLC
  -> Referenced Defined Device Index = 3

Change the following to PS3.3 Annex C in all Attributes description for Referenced Defined Device Index (300A,0602). Affected Tables:

Table C.36.2.2.8-1 RT Beam Limiting Devices Definition Macro Attributes

Table C.36.2.2.10-1 Wedges Definition Macro Attributes

Table C.36.2.2.12-1 Compensators Definition Macro Attributes

Table C.36.2.2.13-1 Blocks Definition Macro Attributes

Table C.36.2.2.14-1 RT Accessory Holders Definition Macro Attributes

Table C.36.2.2.15-1 General Accessories Definition Macro Attributes

Table C.36.2.2.16-1 Boluses Definition Macro Attributes

…			
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The **~~description~~** **device identification** of the two devices may or may not be the same. The value is the index of a device in the RT Beam Limiting Device Definition Sequence (300A,064D) within the single SOP Instance

			referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. **See C.36.2.2.8.1.5.**
…			

Update the following in PS3.3 Annex C:

C.36.10.1 RT Radiation Set Attribute Description

C.36.10.1.1 RT Radiation Set Intent and RT Radiation Record Set Usage

Defined Terms for RT Radiation Set Intent (300A,0637) **and RT Radiation Set Usage (gggg,7507)** are

TREATMENT

~~The RT Radiation Set~~ This Instance is for **~~the purpose~~ performing or recording ~~of~~** treatment delivery. This does not constitute an approval for treatment. **~~All parameters necessary to guide the delivery of RT Radiations are included.~~**

PLAN_QA

~~The RT Radiation Set~~ This Instance is for validating **or recording** the patient-specific dose. For example, by delivering the RT Radiations to a phantom and comparing the calculated dose to the phantom with actual measurements made in the phantom.

MACHINE_QA

~~The RT Radiation Set~~ This Instance is for **performing or recording** system quality assurance and calibration (geometric, dosimetric or both) procedures of the delivery machine and is not patient-specific.

RESEARCH

~~The RT Radiation Set~~ This Instance is for performing **or recording** research and is not delivered to a patient.

SERVICE

~~The RT Radiation Set~~ This Instance is for **performing or recording** diagnostics**, calibration or ~~and~~ machine** assessment **~~of machine repair or to perform measurements for a maintenance or calibration operation~~** by a service technician.

Add the following to PS3.3 Annex C:

C.36.m1 RT Radiation Record Set Common Module

The RT Radiation Record Set Common Module contains treatment-modality-independent information about a set of delivered RT Radiations.

The RT Radiation Record Set may refer to an RT Radiation Set SOP Instance that has been used to define delivery. It may also record ad hoc delivery.

Table C.36.m1-1
RT Radiation Record Set Common Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.9.2-1 "Extended Content Identification Macro"			
Treatment Session UID	(gggg,7500)	1	A unique identifier of the RT Treatment Session to which this Instance belongs.
Referenced RT Radiation Set Sequence	(gggg,7502)	1C	The RT Radiation Set that contains the RT Radiation Instance(s) referenced by the Instances of the Referenced RT Radiation Record Sequence (gggg,7503). Required if an RT Radiation Set Instance provided instructions to the treatment delivery system. Only a single Item shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
RT Radiation Set Usage	(gggg,7507)	1	A general indication of how the referenced RT Radiation Set was used. The Defined Terms are specified in C.36.10.1.1. This value may differ from the RT Radiation Set Intent (300A,0637) within the Instance referenced by the Referenced RT Radiation Set Sequence (gggg,7502). See C.36.m1.1.3.
Referenced RT Radiation Record Sequence	(gggg,7503)	1	RT Radiation Record SOP Instance(s) representing the record of the current treatment set that has been delivered. One or more Items shall be included in this Sequence. See C.36.m1.1.1.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

RT Radiation Set Delivery Number	(gggg,7504)	1C	Ordinal count of delivery for the referenced RT Radiation Set as represented by the current SOP Instance. Required if Referenced RT Radiation Set Sequence (gggg,7502) is present and RT Radiation Set Usage (gggg,7507) is TREATMENT. May be present otherwise. See C.36.m1.1.2.
Clinical Fraction Number	(gggg,7505)	1C	The total number of Fractions that have been delivered to this point, irrespective of the RT Radiation Set(s) used. Required if Referenced RT Radiation Set Sequence (gggg,7502) is present and RT Radiation Set Usage (gggg,7507) is TREATMENT. May be present otherwise. See C.36.m1.1.2.
RT Radiation Record Set Instance Span	(gggg,7506)	1	Whether the delivery of a fraction is recorded in a single Instance or multiple Instances of RT Radiation Record Set. Enumerated Values: SINGLE MULTIPLE When the value is SINGLE, the full fraction is delivered, all referenced RT Radiation Record Instances start with a Treatment Delivery Type (300A,00CE) of TREATMENT and terminate with a Treatment Termination Status (3008,002A) of NORMAL. See C.36.m1.1.2.

C.36.m1.1 RT Radiation Record Set Common Attribute Descriptions

C.36.m1.1.1 Referenced RT Radiation Record Sequence

All SOP Instances referenced in this Sequence shall be recorded by the same treatment device (specified by the Treatment Device Identification Macro within the RT Delivery Device Common Module).

An RT Radiation Record instance shall be referenced in exactly one RT Radiation Record Set instance. The Treatment Session UID within the RT Radiation Record Set shall be identical to those in the Referenced RT Radiation Record instances.

The SOP Classes referenced in this Sequence shall contain the following Modules:

- Enhanced RT Series specified in section C.36.3.

- Radiotherapy Common Instance Module specified in section C.36.4.
- RT Delivery Device Common Module specified in section C.36.12.
- RT Radiation Record Common Module specified in section C.36.m3.

C.36.m1.1.2 RT Radiation Set Delivery Number and Clinical Fraction Number

The Clinical Fraction Number (gggg,7505) tracks the clinical progress of treatment delivery. The RT Radiation Set Delivery Number (gggg,7504) is a counter that represents the number of deliveries of the referenced RT Radiation Set Instance.

The RT Radiation Set Delivery Number (gggg,7504) of the delivered RT Treatment Fraction shall start with 1 for its first fraction and increase monotonically by 1, throughout all RT Radiation Record Set Instances referencing the same RT Radiation Set Instance identified by its SOP Instance UID (0008,0018), see 7.14.10.

If the same RT Radiation Set is used for all treatments, the values of RT Radiation Set Delivery Number (gggg,7504) and the Clinical Fraction Number (gggg,7505) have the same values.

If all the Radiations start with a RT Treatment Status of TREATMENT and end with a RT termination status of NORMAL, the value of RT Radiation Record Set Instance Span (gggg,7506) is SINGLE.

For some adaptive treatment approaches, details of the device parameters may be altered at the treatment session to accommodate the current position and shape of the patient. In this case, a new RT Radiation Set SOP Instance is used for the subsequent RT Treatment Fractions and the RT Radiation Set Delivery Number (gggg,7504) re-starts at 1.

The Clinical Fraction Number (gggg,7505) is continuously incremented to reflect the clinical progress of a therapeutic series of treatments. In the RT Radiation Record Set for the last of the intended RT Treatment Fractions, this value is expected to equal the Number of Fractions (3010,007D) present in the corresponding RT Prescription.

Below are illustrations of how the multiple tags work together to provide the progress status for an interrupted Radiation (Example 1) and an adapted beam treatment (Example 2).

Example 1

RT Radiation Set contains radiations A, B, RT Radiation Record Sets created are W,X,Y,Z

Table C.36.m1-2
Delivery of a single RT Radiation Set Instance

Treatment Session	Delivered Radiations	Treatment Delivery Type (300A,00CE)	Treatment Termination Status (3008,002A)	RT Radiation Record Set	RT Radiation Record Set Instance Span (gggg,7506)	Clinical Fraction Number (gggg,7505)	RT Radiation Set Delivery Number (gggg,7504)
1	A	TREATMENT	NORMAL	W	MULTIPLE	1	1
	B	TREATMENT	ABNORMAL				
2	B	CONTINUATION	NORMAL	X	MULTIPLE	1	1
	A	TREATMENT	NORMAL	Y	SINGLE	2	2

	B	TREATMENT	NORMAL				
3	A	TREATMENT	NORMAL	Z	SINGLE	3	3
	B	TREATMENT	NORMAL				

Example 2

RT Radiation Set contains radiations A, B; Adapted RT Radiations indicated by (‘) and (“); RT Radiation Sets created are X, Y and Z

Table C.36.m1-3
Delivery of a single RT Radiation Set Instance

Treatment Session	Clinical Fraction Number (gggg,7505	RT Radiation Set Delivery Number (gggg,7504)	RT Radiation Set	Delivered Radiations
1	1	1 (of X)	X	A,B
2	2	2 (of X)	X	A,B
3	3	1 (of Y)	Y	A’,B’
4	4	2 (of Y)	Y	A’,B’
5	5	1 (of Z)	Z	A’’,B’
6	6	3 (of X)	X	A,B

C.36.m2 RT Dose Contribution Record Module

The RT Dose Contribution Record module contains information about the delivered and measured dose.

Table C.36.m2-1
RT Dose Contribution Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Radiation Dose Identification Sequence	(300A,0618)	1	Identify and scope the dose values that are recorded by this RT Radiation Record Set IOD. One or more Items shall be included in this Sequence.
>Radiation Dose Identification Index	(300A,0603)	1	Index of this Item in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced Radiation Dose Identification Index	(gggg,7582)	1C	Radiation Dose Identification Index value that links the Radiation Dose Identification defined by this Sequence Item to the corresponding Item in an RT Radiation Set Instance.

			Required if the Instance referenced in Referenced RT Radiation Set Sequence (gggg,7502) contains a Radiation Dose Identification Sequence Item that corresponds to this Radiation Dose Identification Item.
>Radiation Dose Identification Label	(300A,0619)	1	User-defined label for the Radiation Dose Identification. See C.36.2.1.1.1.
>Conceptual Volume Sequence	(3010,0025)	1	Reference to a Conceptual Volume which received dose during treatment delivery. See C.36.m2.1.1. Only a single Item shall be included in this Sequence.
>>Include Table 10.34-1 "Conceptual Volume Segmentation Reference and Combination Macro Attributes"			
Radiation Dose Sequence	(300A,0617)	1	Describes dose contributed by referenced RT Radiation Record SOP instances. For every SOP instance referenced in Referenced RT Radiation Record Sequence (gggg,7503) exactly one item shall be present in this Sequence.
>Referenced RT Radiation Record Sequence	(gggg,7503)	1	The RT Radiation Record SOP Instance that describes parameters for dose delivery of the recorded Radiotherapy treatment for the Fraction specified in RT Radiation Set Delivery Number (gggg,7504). Only a single Item shall be included in this Sequence. See C.36.m1.1.1.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Radiation Dose Values Parameters Sequence	(300A,061F)	1C	Dose values of this RT Radiation with respect to the dose identification items defined in the Radiation Dose Identification Sequence (300A,0618). Required if Measured Meterset to Dose Mapping Sequence (gggg,7572) is not present. May be present otherwise. The number of Items included in this Sequence shall be the same as the number of Items in the Radiation Dose Identification Sequence (300A,0618).

>>Referenced Radiation Dose Identification Index	(300A,060C)	1	The value of Radiation Dose Identification Index (300A,0603) in the Radiation Dose Identification Sequence (300A,0618) identifying the dose contribution to which this Item in the Radiation Dose Values Parameters Sequence (300A,061F) applies.
>>Meterset to Dose Mapping Sequence	(300A,0620)	1	Mapping of Cumulative Meterset (300A,063C) to Radiation Dose Value (300A,0625). This may be as defined in the RT Radiation Set for the RT Radiation or calculated for this RT Radiation Record Set. See Section C.36.11.1.1. Two or more Items shall be included in this Sequence.
>>>Cumulative Meterset	(300A,063C)	1	Cumulative Meterset where a dose value is delivered. See C.36.C2.1.
>>>Radiation Dose Value	(300A,0625)	1	Dose value (in Gy) delivered at the corresponding Cumulative Meterset (300A,063C). See C.36.C2.1.
>>>Include Table C.36.2.1.5-1 "Radiobiological Dose Effect Description Macro Attributes"			
>Measured Meterset to Dose Mapping Sequence	(gggg,7572)	1C	Measured dose values of this treated radiation mapped to Meterset Values. Required if Calculated Meterset to Dose Mapping Sequence (gggg,7571) is not present. May be present otherwise. One or more Items shall be included in this Sequence.
>>Referenced Expected In-Vivo Measurement Value Index	(gggg,7573)	3	Expected In-Vivo Measurement Value Index (300A,0622) in the Expected In-Vivo Measurement Value Sequence (300A,0621) from the RT Radiation Set Instance that is being recorded.
>>Cumulative Meterset	(300A,063C)	1	Cumulative Meterset where a dose value is delivered. See C.36.C2.1.
>>Radiation Dose Value	(300A,0625)	1	Dose value in Gy delivered at the corresponding Cumulative Meterset (300A,063C) of the current SOP Instance. See C.36.C2.1.
>>Measured Dose Type	(3008,9014)	2	Type of dose measurement.

			Defined Terms: DIODE = semiconductor diode TLD = thermo-luminescent dosimeter ION_CHAMBER = ion chamber GEL = dose sensitive gel EPID = electronic portal imaging device FILM = dose sensitive film
>>Measured Dose Description	(3008,9012)	3	User-defined description of Measured Dose (e.g. “Exit dose”, “Point A”).

C.36.m2.1 RT Dose Contribution Record Module Attribute Descriptions

C.36.m2.1.1 Conceptual Volume Sequence

The Conceptual Volume Sequence (3010,0025) identifies a Conceptual Volume defining a volume for which dose has been recorded during treatments.

If the Conceptual Volume is associated with a segment, the segment is defined by the Referenced Segment Reference Index (3010,0020) in the Conceptual Volume Segmentation Reference and Combination Macro (see section 10.34).

Alternatively, the Conceptual Volume might not be associated with a segment; for example when dose recording is specified using a nominal dose to a volume and the tracking coefficients are approximated by Meterset values.

Typically, this Module references Conceptual Volumes which have been used in the RT Dose Contribution Module of the RT Radiation Set SOP Instance referenced by the Referenced RT Radiation Set Sequence (gggg,9C02).

C.36.m3 RT Radiation Record Common Module

The RT Radiation Record Common Module contains treatment-modality-independent information about a delivered RT Radiation. A delivered RT Radiation may be radiation to a patient or radiation without a patient being present (e.g. for QA purposes).

Table C.36.m3-1
RT Radiation Record Common Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.9.2-1 “Extended Content Identification Macro”			
Treatment Session UID	(gggg,7500)	1	Uniquely identifies the RT Treatment Session to which this instance belongs.

RT Radiation Physical and Geometric Content Detail Flag	(300A,0638)	1	The level of detail of content within this SOP Instance. Enumerated Values: FULL The physical and geometric parameters of all devices are fully defined and dosimetric information is present. This level of detail is typically present after volumetric planning. IDENT_ONLY The physical and geometric parameters of all devices may not be fully specified, but the devices can be identified and dosimetric information is present. GEOMETRY_ONLY The geometric parameters of all devices are fully specified, but no dosimetric information is present. This level of detail is typically present after Virtual Simulation.
RT Record Flag	(300A,0639)	1	Whether or not device parameters about actual delivery of treatment to a patient have been recorded. Enumerated Values: YES - Values in this Instance are a record of a delivered treatment, based on e.g. read-outs or measurements. NO - Values in this Instance are a specification of a treatment to be delivered, e.g. by a treatment planning system.
Referenced RT Instance Sequence	(300A,0631)	1C	The RT Radiation SOP Instance that provided the instruction to deliver the radiation. Required if an RT Radiation SOP Instance was used to provide the instructions to the delivery system. Only a single Item shall be included in this Sequence. See C.36.10.1.2.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
RT Treatment Technique Code Sequence	(3010,0080)	1	Type of treatment technique. Only a single Item shall be included in this Sequence. See Section C.36.13.1.1.

>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID is defined in the IOD including this Module.*
Include Table C.36.2.2.4-1 "RT Treatment Position Macro Attributes"			*See Section C.36.13.1.2.*
RT Tolerance Set Sequence	(300A,0629)	3	A set of tolerance values for parameters used for delivery of the RT Radiation. Only a single Item is permitted in this Sequence.
>Include Table C.36.2.2.17-1 "RT Tolerance Set Macro Attributes"			
Treatment Machine Special Mode Code Sequence	(300A,0635)	1C	A mode of operation on the treatment machine. Required if a special delivery mode is used for treatment. Only a single Item shall be included in this Sequence. See Section C.36.13.1.4.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Defined CID is defined in the IOD including this Module.*
Treatment Delivery Type	(300A,00CE)	1	Delivery Type of treatment. Defined Terms: TREATMENT = normal treatment of patient CONTINUATION = continuation of interrupted treatment PLAN_QA = Treatment used for Quality Assurance rather than patient treatment
Treatment Termination Status	(3008,002A)	1	Termination status of the recorded treatment. Enumerated Values: NORMAL The fraction represented by the referenced Radiation IOD has been completely delivered and terminated as expected. ABNORMAL The fraction represented by the referenced Radiation IOD has been incompletely delivered or did not terminate as expected.

Treatment Termination Reason Code Sequence	(gggg,7515)	2C	Treatment machine termination code. This code is dependent upon the particular application and equipment. Required if Treatment Termination Status (3008,002A) is ABNORMAL Zero or more items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Defined CID SUP199001 "Treatment Termination Reasons"*
Machine-Specific Treatment Termination Code Sequence	(gggg,7516)	3	Machine-specific termination codes. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Treatment Termination Description	(gggg,7530)	2C	A user-readable description for an abnormal termination. Required if Treatment Termination Status (3008,002A) is ABNORMAL.
Treatment Tolerance Status	(gggg,7536)	2	Tolerance status of delivery. Enumerated Values: IN_TOLERANCE = Delivery remained within tolerance. MACH_TOL = Delivery went out of machine tolerance. MACH_TOL_OVR = Delivery went out of machine tolerance and was overridden by operator. CLINICAL_TOL = Machine went out of clinically accepted tolerance and was not overridden by operator. CLINICAL_TOL_OVR = Machine went out of clinically accepted tolerance and was overridden by operator.
Recorded RT Control Point Sequence	(gggg,7539)	1	Lists the RT Control Points recorded in this Instance. The number of Items included in this Sequence shall equal the value of Number of RT Control Points (300A,0604). See C.36.m3.1.1.

>Referenced Radiation RT Control Point Index	(gggg,753B)	1C	The value of RT Control Point Index (300A,0600) of the RT Control Point in the RT Radiation SOP Instance referenced by Referenced RT Instance Sequence (300A,0631) in this Instance. Required if the recorded RT Control Point Index corresponds to a planned RT Radiation Control Point Index.
>Referenced Record RT Control Point Index	(gggg,753C)	1	The value of RT Control Point Index (300A,0600) of the RT Control Point referenced by this Item.
>Recorded RT Control Point DateTime	(gggg,753A)	1	Date and time of the Recorded RT Control Point. For all but the final Control Point this shall be the date and time when the delivery of radiation at this Control Point began. For the final Control Point this shall be the date and time when the previous control point ended.
Override Sequence	(3008,0060)	2	Parameters that were re-specified or overridden immediately prior to treatment delivery. Zero or more Items shall be included in this Sequence.
>Include Table 10-20a "Extended Selector Attribute Macro Attributes"			
>Operator Identification Sequence	(0008,1072)	1	Identification of the operator who authorized the override. One or more Items shall be present.
>>Include Table 10-1 "Person Identification Macro Attributes"			
>Override Type Code Sequence	(gggg,7561)	1	Type of parameter override. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Defined CID SUP199007 "Treatment Parameter Override Types"*
>Override DateTime	(gggg,7560)	1	Date and Time when the user authorized the override.
>Override Reason	(3008,0066)	2	User-defined description of the reason for override of the parameter.
>Alternate Specified Value Sequence	(gggg,753E)	2C	New value for the parameter specified by Selector Attribute (0072,0026). Required if the selected content is a single Attribute of any VR other than SQ. Zero or one Item shall be included in this Sequence.

>>Include Table 10.26-1 "Attribute Value Macro Attributes"			
Sign-Off Sequence	(gggg,753F)	2	Records sign-offs by treatment session operators of details that may not be verified electronically (e.g. the presence of devices). Zero or more Items shall be included in this Sequence.
>Include Table 10-30-1 "Assertion Macro Attributes"			*Baseline CID for Assertion Code Sequence (0044,0101) is CID SUP199005 "Treatment Session Sign-Off Assertions".*
Interlock Sequence	(gggg,7540)	2	Interlocks which occurred prior, during or after the delivery of radiation covered by this SOP Instance. Zero or more Items shall be included in this Sequence.
>Interlock DateTime	(gggg,7541)	1	Date and Time when the Interlock occurred. The date and time of occurrence may be when the interlock occurred (e.g. by a real-time system) or when the interlock was recorded. See C.7.4.2.1.4:
>Interlock Description	(gggg,7542)	1	User-readable description of the interlock.
>Interlock Origin Description	(gggg,7583)	1C	Description of the origin of the interlock. Required when Interlock Origin Sequence (gggg,7543) is not present.
>Interlock Origin Sequence	(gggg,7543)	1C	Contains the attributes that identify the device that originated the interlock. Only a single Item shall be included in this Sequence. Required when Interlock Origin Description (gggg,7583) is not present.
>>Include Table 10.36-1 "Device Identification Macro Attributes"			*No Baseline CID is defined.*
>Interlock Code Sequence	(gggg,7544)	1	Code(s) that describe the interlock(s) that occurred. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Baseline CID is SUP199008 "Treatment Interlocks".*

>Interlock Resolution Code Sequence	(gggg,7545)	1	The action applied to resolve the interlock. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Defined CID SUP199004 "Interlock Resolution"*
>Interlock Resolution User Sequence	(gggg,7546)	1	The user that resolved the interlock. One or more Items shall be included in this Sequence.
>>Include Table 10-1 "Person Identification Macro Attributes"			
Additional Parameter Recording Instance Sequence	(gggg,7580)	3	SOP Instances that contain additional recording of treatment parameters. One or more Items are permitted in this Sequence. See C.36.m3.1.2.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Creator-Version UID	(0008,9123)	2	Identifies the combination of equipment and software version that created the referenced Instance.

C.36.m3.1 RT Radiation Record Common Attribute Descriptions

C.36.m3.1.1 Control Point References

The Control Points recorded by the Recorded RT Control Point Sequence (gggg,7539) refer to the Control Points contained in the specific RT Radiation Modules within this IOD, see Table C.36.m3-2.

Table C.36.m3-2
Referenced Control Points

Module	RT Control Point Sequence Attribute	Tag
C-Arm Photo-Electron Beam	C-Arm Photon-Electron Control Point Sequence	(300A,062F)
Tomotherapeutic Beam	Tomotherapeutic Control Point Sequence	(gggg,1010)
Robotic-Arm Path	Robotic Path Control Point Sequence	(gggg,9F50)

The number of Control Points and / or the Control Point definitions in that Sequence may be different than the number of Control Points in the Control Point Sequence in the referenced RT Radiation IOD. There are mainly two reasons for this; the actual radiation delivery may have been performed differently or the treatment device may record the Control Points at a different granularity.

C.36.m3.1.2 Additional Parameter Recording Instance Sequence

The Additional Parameter Recording Instance Sequence (gggg,7580) allows references a SOP Instance which contains additional parameters recorded during the delivery. For example, the recording may be high-frequency samples of certain parameters to allow in-depth analysis for quality assurance or other purposes.

C.36.m4 Manual Radiation Record Module

The Manual Radiation Record Module contains information about the values which have been recorded manually for a delivery of an RT Radiation.

Table C.36.m4-1
Manual Radiation Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Final Meterset	(gggg,7520)	1	Manually recorded final Meterset value. The units are specified by Radiation Dosimeter Unit Sequence (300A,0658). See C.36.1.1.3.
Nominal Energy	(300A,0680)	1C	The nominal beam energy in units as defined in the Energy Unit Code Sequence (300A,0684).
Energy Unit Code Sequence	(300A,0684)	1	The unit of energy values specified in Nominal Energy (300A,0680). Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Defined CID 9521 "Radiotherapy Treatment Energy Unit".*

Part 4 Addendum

2 **Add the following to PS3.4, Appendix B.5, Table B.5-1**

SOP Class Name	SOP Class UID	IOD Spec (defined in PS 3.3)
RT Radiation Record Set Storage	**1.2.840.10008.5.1.4.1.1.481.XN.6.1**	**RT Radiation Record Set IOD**
Manual Radiation Record Storage	**1.2.840.10008.5.1.4.1.1.481.XN.6.2**	**Manual Radiation Record IOD**
Tomotherapeutic Radiation Record Storage	**1.2.840.10008.5.1.4.1.1.481.XN.6.3**	**Tomotherapeutic Radiation Record IOD**
C-Arm Photon-Electron Radiation Record Storage	**1.2.840.10008.5.1.4.1.1.481.XN.6.4**	**C-Arm Photon-Electron Radiation Record IOD**
Robotic Radiation Record Storage	**1.2.840.10008.5.1.4.1.1.481.XN.6.6**	**Robotic Radiation Record IOD**

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Part 6 Addendum

Add the following data elements to PS3.6:

6 REGISTRY OF DICOM DATA ELEMENTS

(gggg,7500)	Treatment Session UID	TreatmentSessionUID	UI	1
(gggg,7501)	Referenced RT Patient Setup Sequence	ReferencedRTPatientSetupSequence	SQ	1
(gggg,7502)	Referenced RT Radiation Set Sequence	ReferencedRTRadiationSetSequence	SQ	1
(gggg,7503)	Referenced RT Radiation Record Sequence	ReferencedRTRadiationRecordSequence	SQ	1
(gggg,7504)	RT Radiation Set Delivery Number	RTRadiationSetDeliveryNumber	US	1
(gggg,7505)	Clinical Fraction Number	ClincalFractionNumber	US	1
(gggg,7506)	RT Radiation Record Set Instance Span	RTRadiationRecordSetInstanceSpan	CS	1
(gggg,7507)	RT Radiation Set Usage	RTRadiationSetUsage	CS	1
(gggg,7515)	Treatment Termination Reason Code Sequence	TreatmentTerminationReasonCodeSequence	SQ	1
(gggg,7516)	Machine-Specific Treatment Termination Code Sequence	MachineSpecificTreatmentTerminationCodeSequence	SQ	1
(gggg,7520)	Final Meterset	FinalMeterset	FD	1
(gggg,7530)	Treatment Termination Description	TreatmentTerminationDescription	ST	1
(gggg,7536)	Treatment Tolerance Status	TreatmentToleranceStatus	CS	1
(gggg,7539)	Recorded RT Control Point Sequence	RecordedRTControlPointSequence	SQ	1
(gggg,753A)	Recorded RT Control Point DateTime	RecordRTControlPointDateTime	DT	1
(gggg,753B)	Referenced Radiation RT Control Point Index	ReferencedRadiationRTControlPointIndex	US	1
(gggg,753C)	Referenced Record RT Control Point Index	ReferencedRecordRTControlPointIndex	US	1
(gggg,753E)	Alternate Specified Value Sequence	AlternateSpecifiedValueSequence	SQ	1
(gggg,753F)	Sign-Off Sequence	SignOffSequence	SQ	1
(gggg,7540)	Interlock Sequence	InterlockSequence	SQ	1
(gggg,7541)	Interlock DateTime	InterlockDateTime	DT	1
(gggg,7542)	Interlock Description	InterlockDescription	ST	1
(gggg,7543)	Interlock Origin Sequence	InterlockOriginSequence	SQ	1
(gggg,7544)	Interlock Code Sequence	InterlockCodeSequence	SQ	1
(gggg,7545)	Interlock Resolution Code Sequence	InterlockResolutionCodeSequence	SQ	1

(gggg,7546)	Interlock Resolution User Sequence	InterlockResolutionUserSequence	SQ	1
(gggg,7560)	Override DateTime	OverrideDateTime	DT	1
(gggg,7561)	Override Type Code Sequence	OverrideTypeCodeSequence	SQ	1
(gggg,7571)	Calculated Meterset to Dose Mapping Sequence	CalculatedMetersetToDoseMapping Sequence	SQ	1
(gggg,7572)	Measured Meterset to Dose Mapping Sequence	MeasuredMetersetToDoseMapping Sequence	SQ	1
(gggg,7573)	Referenced Expected In-Vivo Measurement Value Index	ReferencedExpectedInVivoMeasure mentValueIndex	US	1
(gggg,7580)	Additional Parameter Recording Instance Sequence	AdditionalParameterRecordingInsta nceSequence	SQ	1
(gggg,7582)	Referenced Radiation Dose Identification Index	ReferencedRadiationDoseIdentificati onIndex	US	1
(gggg,7583)	Interlock Signal Source Description	InterlockSignalSourceDescription	LO	1

2

Add the following to PS3.6 Annex A:

ANNEX A REGISTRY OF DICOM UNIQUE IDENTIFIERS (UID) (NORMATIVE)

Table A-1 UID Values

UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.5.1.4.1.1.481.XN.6.1	RT Radiation Record Set Storage	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.481.XN.6.2	Manual Radiation Record Storage	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.481.XN.6.3	Tomotherapeutic Radiation Record Storage	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.481.XN.6.4	C-Arm Photon-Electron Radiation Record Storage	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.481.XN.6.6	Robotic Radiation Record Storage	SOP Class	PS 3.4

Table A-3 Context Group UID Values

Context UID	Context Identifier	Context Group Name
1.2.840.10008.6.1.S199.001	SUP199001	Treatment Termination Reasons
1.2.840.10008.6.1.S199.002	SUP199002	Radiotherapy Treatment Delivery Person Roles
1.2.840.10008.6.1.S199.004	SUP199004	Interlock Resolution
1.2.840.10008.6.1.S199.005	SUP199005	Treatment Session Sign-Off
1.2.840.10008.6.1.S199.007	SUP199007	Treatment Parameter Override Types
1.2.840.10008.6.1.S199.008	SUP199008	Treatment Interlocks

Part 16 Addendum

Add the following new CIDs to PS3.16, Annex B:

CID SUP199001 TREATMENT TERMINATION REASONS

Context ID SUP199001

Treatment Termination Reasons

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML

Type: Extensible

Version: yyyymmdd

UID: 1.2.840.10008.6.1.S199.001

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)	SNOMED-RT Concept ID	UMLS Concept Unique ID
Include CID SUP199008 "Treatment Interlocks"				
SCT	39104002	Illness		
SCT	419620001	Death	R-102FC	
99SUP199	S199102	Operator Decision		
99SUP199	S199103	Patient Decision		
99SUP199	S199104	Physician Decision		

CID SUP199002 RADIOTHERAPY TREATMENT DELIVERY PERSON ROLES

Context ID SUP199002

Radiotherapy Treatment Delivery Person Roles

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML

Type: Extensible

Version: yyyymmdd

UID: 1.2.840.10008.6.1.S199.002

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)	SNOMED-RT Concept ID	UMLS Concept Unique ID
SCT	3430008	Radiation Therapist	J-06173	C0278604
SCT	158965000	Medical Practitioner	J-0016E	C1306754
SCT	309343006	Physician	J-004E8	C0031831
NCIt	C93176	Dosimetrist		C2985479
SCT	405277009	Resident	J-005E6	C1320928
UMLS	C1441532	Consulting Physician		C1441532
UMLS	C2985483	Radiation Physicist		C2985483
DCM	128678	Physics Assistant		

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)	SNOMED-RT Concept ID	UMLS Concept Unique ID
UMLS	C1708969	Medical Physicist		C1708969

CID SUP199004 INTERLOCK RESOLUTIONS

Context ID SUP199004

Interlock Resolution

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML

Type: Extensible

Version: yyyymmdd

UID: 1.2.840.10008.6.1.S199.004

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)	SNOMED-CT Concept ID	UMLS Concept Unique ID
99SUP199	S199400	Treatment Terminated		
99SUP199	S199401	Interlock Overridden		
99SUP199	S199402	Patient Repositioned		

CID SUP199005 TREATMENT SESSION SIGN-OFF ASSERTIONS

Context ID SUP199005

Treatment Session Sign-Off Assertions

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML

Type: Extensible

Version: yyyymmdd

UID: 1.2.840.10008.6.1.S199.005

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)	SNOMED-CT Concept ID	UMLS Concept Unique ID
99SUP199	S199500	Bolus Present		
99SUP199	S199501	Cone Present		

CID SUP199007 TREATMENT PARAMETER OVERRIDE TYPES

Context ID SUP199007

Treatment Parameter Override Types

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML

Type: Extensible

Version: yyyymmdd

UID: 1.2.840.10008.6.1.S199.007

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)	SNOMED-CT Concept ID	UMLS Concept Unique ID
99SUP199	S199700	Beam Targeting Adjustment		
99SUP199	S199701	Meterset Adjustment		
99SUP199	S199702	Delivery Rate Adjustment		
99SUP199	S199703	Tolerance Adjustment		

CID SUP199008 TREATMENT INTERLOCKS

Context ID SUP199008

Treatment Interlocks

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML

Type: Extensible

Version: yyyymmdd

UID: 1.2.840.10008.6.1.S199.008

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)	SNOMED-RT Concept ID	UMLS Concept Unique ID
99SUP199	S199801	Secondary Fluence Monitoring System Interlock		
99SUP199	S199802	Timer Interlock		
99SUP199	S199803	Door Interlock		
99SUP199	S199804	Patient Motion Interlock		

Add the following new CIDs to PS3.16, Annex D:

2

ANNEX D DICOM CONTROLLED TERMINOLOGY DEFINITIONS (NORMATIVE)

4

Code Value	Code Meaning	Definition	Notes
S199102	Operator Decision	Operator decided to discontinue treatment.	
S199103	Patient Decision	Patient decided to discontinue treatment.	
S199104	Physician Decision	Physician decided to discontinue treatment.	
S199400	Treatment Terminated	The delivery of this RT Radiation was terminated.	
S199401	Interlock Overridden	An out-of-tolerance delivery parameter was accepted or re-specified.	
S199402	Patient Repositioned	The treatment was continued after the patient was re-positioned.	
S199500	Bolus Present	The bolus is confirmed to be present.	
S199501	Cone Present	The cone is confirmed to be present.	
S199700	Beam Targeting Adjustment	Parameters have been adjusted to better match the target.	
S199701	Meterset Adjustment	Adjusted Meterset value has been accepted.	
S199702	Delivery Rate Adjustment	Adjusted Delivery Rate has been accepted.	
S199703	Tolerance Adjustment	Adjusted Tolerance has been accepted.	
S199801	Secondary Fluence Monitoring System Interlock	An interlock triggered by a measured fluence.	
S199802	Timer Interlock	An interlock triggered by a timer.	
S199803	Door Interlock	An interlock triggered by a door being open.	
S199804	Patient Motion Interlock	An interlock triggered by patient movement.	