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Digital Imaging and Communications in Medicine (DICOM)

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Supplement 178: Second Generation Radiotherapy –

RT Course

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DICOM Standards Committee, Working Group 7, Radiation Therapy

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Table of Contents

68   **Foreword**

70 This Supplement in its current state represents the remaining sections of Supplement 147, revision 42, which is being split into several smaller attributes.

72 Attribute definitions, CID definitions and DICOM Controlled terminology are currently not part of this document, but remain in their entirety in Supplement 147 until it is ready for Public Comment. Then the remaining parts of these chapters will be moved to this document.

74 This Supplement specifies the additional IODs necessary to support the new Second Generation Radiotherapy IODs and operations.

76 This document is an extension to the following parts of the published DICOM Standard:

PS 3.2	Conformance
PS 3.3	Information Object Definitions
PS 3.4	Service Class Specifications
PS 3.6	Data Dictionary
PS 3.16	Content Mapping Resource

82   **Scope and Field of Application**

Introduction

84 Existing radiotherapy IODs were designed to provide a set of containers for use in communicating radiation therapy data of all types, in a generic and flexible way.

86 Since the development of the initial IODs, both radiation therapy practice and the DICOM Standard itself have evolved considerably. In particular, workflow management is now a key aspect of
88 DICOM's domain of application, and the introduction of Unified Worklist and Procedure Step (by Supplement 74 in conjunction with Supplement 96) have begun the growth of radiation therapy into
90 workflow management.

92 This supplement addresses the need for a new generation of IODs and processes required for use in radiation therapy. The general principles under which these IODs and processes have been developed are documented below.

94 **General Architectural Principles**

96 The DICOM "STRATEGIC DOCUMENT Version 10.4, October 25, 2010" outlines a number of principles applicable across the entire DICOM standard. The key relevant points, and how this supplement addresses those concerns, are as follows:

98 •   Image IOD development follows the "enhanced multi-frame" paradigm, rather than stacks of 2D SOP Instances. The new RT Dose Image follows this paradigm.

100 • Different representations of data are encoded in different IODs. This is in contrast to first-generation objects, where multiple different types of data are encoded in a single IOD, such as
102   RT Structure Set.

• These new IODs do not define an architecture for the entire system, or functional requirements
104   beyond behavior required for specific services. This is because the mode of manual exchange of objects (see PS3.17) supports an arbitrary system architecture. The worklist mode of
106   operation does place some constraints on the architecture – for example, it implies the existence of one or more workflow servers that have knowledge of department-wide scheduling.
108   The Radiation Oncology domain of the IHE initiative may adapt workflows that will utilize 2nd Generation Radiotherapy objects and define their usage in a clinical workflow, as it was done
110   with Supplement 74 and the IHE-RO Technical Profile "Treatment and Delivery Workflow".

RT Architectural Principles

112 In addition to the general principles outlined above, additional principles specific to radiation therapy have been used in the development of this supplement:

114 • Support for available technologies: The new IODs are designed to support legacy and full-featured, modern equipment.

116 • Compatibility with First-Generation IODs: In general, where the technologies continue to be supported, it will be possible for the content of first-generation IODs to be re-encoded into the
118   second generation IODs described in the supplement. However, such a translation will not be a basic re-encoding and will require additional information supplied by the translating device.

120 • New data representation approaches in DICOM: Where possible, use has been made of new and powerful approaches, such as 3D segmentation, mesh representation, rigid and deformable
122   registrations.

• IODs specific to use cases: Explicit separate IODs have been developed for specific treatment
124   modalities with the concept of RT Radiation IOD – for example, Tomotherapeutic, C-Arm, and Robotic beams are modeled separately. This allows more stringent conditions to be applied to
126   the presence or absence of attributes within those IODs, and thereby increases the potential for interoperability.

128 • Expandability of concept: New treatment modalities currently not considered by this standard can be modeled along the existing RT Radiation IODs and be introduced later on, fitting into the
130   existing concept.

• Workflow Management: The concept of workflow management using Unified Procedure Step
132   has been fully integrated into the new IODs. However, specific instruction and result IODs needed for some of these workflows will be standardized in a subsequent supplement.

134 • New techniques in oncology: The existence of new treatment techniques (such as robotic therapy and tomotherapy) have been taken into account, along with new treatment strategies
136   (such as image-guided therapy and adaptive therapy).

See Part 17 for descriptions of new radiotherapy entities and sample use cases.

138   **Part 2 Addendum**

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

140

UID Value	UID Name	Category
1.2.840.10008.5.1.4.1.1.481.XN.1	RT Course Storage	Transfer

142   **Part 3 Addendum**

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

4

IODs Modules	RT Course
Patient	M
Clinical Trial Subject	U
General Study	M
Patient Study	U
Clinical Trial Study	U
General Series	M
Clinical Trial Series	U
Enhanced RT Series	M
General Equipment	M
Enhanced General Equipment	M
Frame Of Reference	
Synchronization	
Radiotherapy Common Instance	M
RT Course	M
RT Prescription Reference	C
RT Treatment Phase	C

IODs Modules	RT Course
RT Radiation Set Reference	C
RT Course Associated Instance Reference	U
Common Instance Reference Module	M
SOP Common	M

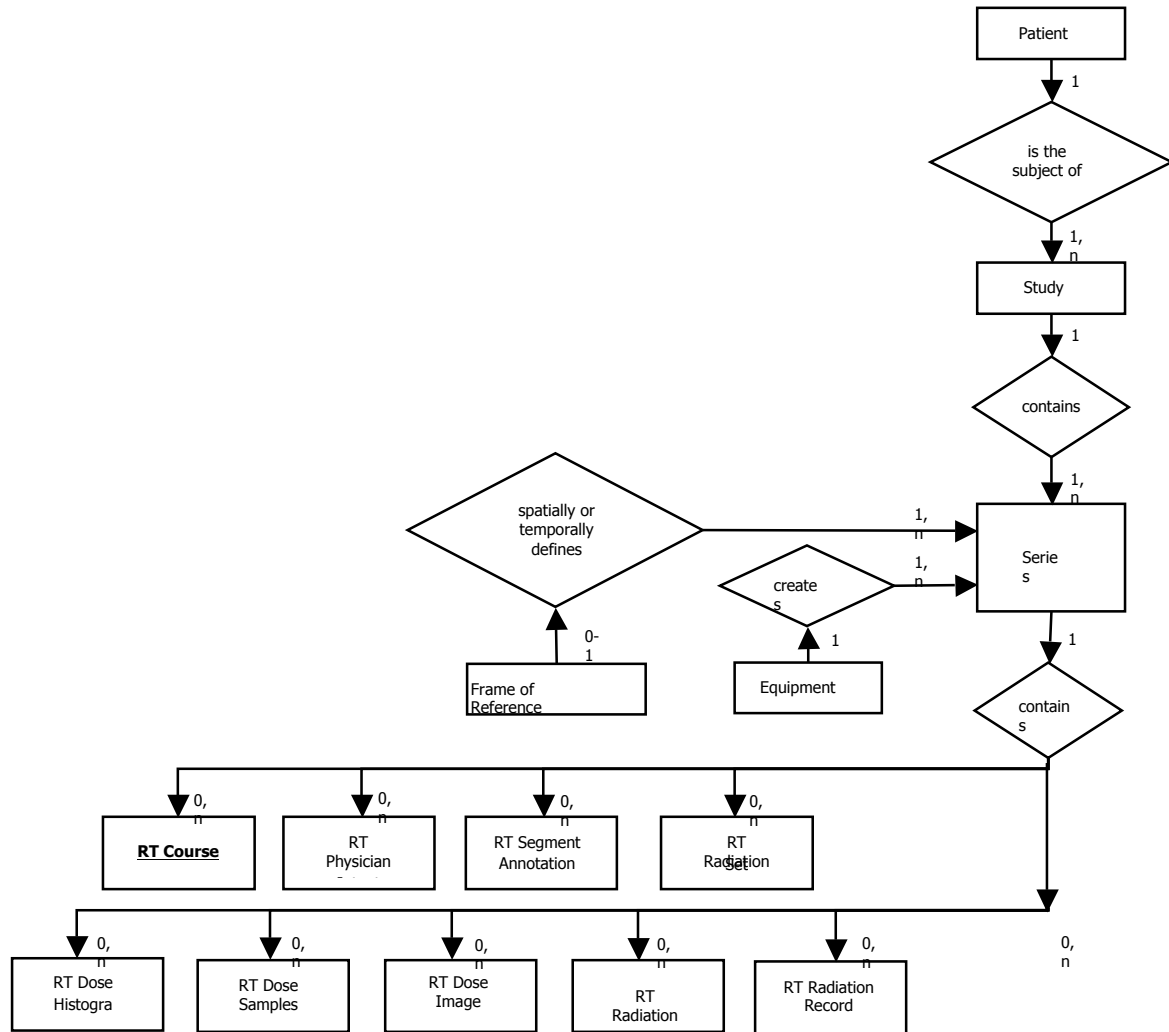Add the following to PS3.3 Annex A:

2 A.VV   SECOND GENERATION RADIATION THERAPY

A.VV.1.1.1   Second Generation Radiation Therapy Entity-Relationship Model

4   The E-R Model in Figure A.VV.1.1.1-1 depicts those components of the DICOM Information Model that are relevant to second-generation RT IODs.

6

8   **Figure A.VV.1.1.1-1 — RT Second Generation IOD information model**

2   **A.VV.1.2   RT Course Information Object Definition**

   A.VV.1.2.1   RT Course IOD Description

4   The RT Course IOD binds together various entities needed in radiotherapy for preparation, execution
    and review of radiotherapeutic treatment of a patient. It facilitates complete archiving of a RT
6   treatment delivery and communication of data needed for planning or treatment steps not managed
    by DICOM workflow.

8   The content of an RT Course may undergo frequent updates resulting in a new SOP Instance UID
    following each update. As a result, querying for the current RT Course object may return a SOP
10 Instance UID different than previously used to access the object.

    See PS 3.17 for further explanation.

12 **A.VV.1.2.2   RT Course IOD Entity-Relationship Model**

    See Figure A.VV.1.1.1-1.

14 **A.VV.1.2.3   RT Course IOD Module Table**

<div align="center">

Table A.VV.1.2-4

16 **RT COURSE IOD MODULES**

</div>

IE	Module	Reference	Usage
Include 'RT Second Generation IOD Modules Macro' Table A.VV.1.1.1-1			
RT Course	RT Course	C.AA.A3	M
	RT Prescription Reference	C.AA.A4	C Required if RT Prescription Reference Presence Flag (30xx,0805) equals YES.
	RT Treatment Phase	C.AA.A5	C Required if RT Treatment Phase Presence Flag (30xx,0806) equals YES.
	RT Radiation Set Reference	C.AA.A6	C Required if RT Radiation Set Reference Presence Flag (30xx,0807) equals YES.
	RT Course Associated Instance Reference	C.AA.A7	U

18

2 ## C.AA.2   Second Generation Radiotherapy General-Purpose Macros

C.AA.2.3   RT Item State Macro

4 This macro is invoked to record the clinical state, such as approval or review, of either an entire SOP Instance or a specific part of the information content of a SOP Instance.

6 **Table C.AA.2.3-1**
RT ITEM STATE MACRO ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
RT Item State Sequence	(30xx,5080)	1	States that have been set on the item that the RT Item State belongs to. One or more Items shall be included in this sequence.
>Include 'Assertion Macro' Table 10-XW1-1 *(Editor's Note: That Macro is defined in Sup 121. The version referenced in here is Sup 121_pc,October 2013)*			*No Baseline CID defined.* *See C.AA.2.3.1.1.*
>Active Item Indicator	(30xx,5082)	1	Indicator of the active versus historic status of this item. Enumerated Values: ACTIVE HISTORIC See C.AA.2.3.1.2.
>RT Item State Creation Authority Description Sequence	(30xx,5084)	3	User defined description of authority used to create this Item State entry.
>>Include 'HL7v2 Hierarchic Designator' Macro Table 10-17			

8

C.AA.2.3.1   RT Item State Macro Attribute Description

10 ### C.AA.2.3.1.1   RT Item State Sequence

The RT Item State Sequence (30xx,5080) contains a sequence of Items which define the state. The
12 CIDs which define the codes to be used in Assertion Code Sequence (30xx,50A0) attribute of the Assertion Macro are defined at the invocation of the macro.

14 ### C.AA.2.3.1.2   Active Item Indicator

The Active Item Indicator (30xx,5082) attribute is used to specify which state definiton items in the RT
16 Item State Sequence (30xx,5080) are active and which items do only convey an audit trail of states having been in place in the past .

18 This indication additionally allows conveying more than one state entry of different persons as being active. E.g. if the department requires approvals by more than one person, several items having an
20 approved state can be marked as active, indicating the list of persons having provided approval.

2   The semantics of the states are defined in the code definition and may be further specialized at invocation of that macro. Which state transitions are allowed and which are the pre-conditions to perform a state transition if outside of the scope of the standard.

4   **C.AA.2.4   RT Operation State Macro**

6   This macro describes the attributes that record the operation state of referenced SOP Instances. The RT Operation State encodes the progress of the entity through the delivery process, rather than the approval state as encoded in RT Item State (see Section C.AA.2.3).

8   The initial state of a SOP Instance, to which the sequence applies, is undefined and specified by an empty sequence.

10   **Table C.AA.2.4-1**
RT OPERATION STATE MACRO ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
RT Operation State Sequence	(30xx,5086)	2	Operation state of the item the state belongs to. The current state is the one with the latest Date/Time as denoted in Assertion Macro in Assertion DateTime (30xx,50A4). Zero or more Items shall be included in this sequence.
RT Operation State Code Sequence	(30xx,508A)	1	The code representing the operation state. Only a single Item shall be included in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1			*Defined CID shall be SUP147044.*
Author Observer Sequence	(0040,A078)	1C	The person or device updating the operation state. Only a single Item shall be included in this sequence.
>Include 'Identified Person or Device Macro' Table C.17-3b (Editor's Note: That Macro used here is one defined in PS3.3 with the extensions of Sup 121. The supplement version referenced in here is Sup 121_pc, 2013-04-11)			*No Baseline CIDs defined*
RT Operation State DateTime	(30xx,508C)	1	Date and time at which the operation state did change.
RT Operation State Change Reason Description	(30xx,508E)	3	Description of the reason for moving to this state, especially in the case of early completion
>RT Operation State Change Reason Code Sequence	(30xx,5088)	3	Code describing the reason for moving to this state, especially in the case of early completion. Only a single Item shall be included in this sequence.

>>Include 'Code Sequence Macro' Table 8.8-1	No Baseline CID is specified.

2 **C.AA.A3   RT Course Module**

The RT Course module contains general information for the RT Course IOD.

4   **Table C.AA.A3-1**
                                 RT COURSE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description

RT Course Scope Indicator	(30xx,0804)	2	Definition of the scope of this RT Course.
			Defined Terms:
			    PARTIAL = RT Course SOP Instance contains a subset of all data related to the treatment course at the time it was created.
			    COMPLETE = The RT Course originated from an application with an authoritative role in managing the RT Course in a department.
			See C.AA.A3.1.1.

RT Prescription Reference Presence Flag	(30xx,0805)	1	Defines whether an RT Prescription Reference is present.
			Enumerated Values:
			    YES
			    NO

RT Treatment Phase Presence Flag	(30xx,0806)	1	Defines whether an RT Treatment Phase definition is present.
			Enumerated Values:
			    YES
			    NO

RT Radiation Set Reference Presence Flag	(30xx,0807)	1	Defines whether a RT Radiation Set Reference is present.
			Enumerated Values:
			    YES
			    NO

Current Course Predecessor Sequence	(30xx,080A)	2	Reference to historical versions of the RT Course. Zero or more Items shall be included in this sequence.
>Include 'SOP Instance Reference Macro' Table 10-11			

Attribute Name	Tag	Type	Description
Prior Treatment Sequence	(30xx,0822)	2C	Former treatments that have been delivered to this patient. Required if a previous radiation therapy treatment of the patient occurred and is known. Zero or more Items shall be included in this sequence.
>Prior RT Course Sequence	(30xx,0824)	1C	Reference to an RT Course previously established and terminated. Required if Delivered Radiation Dose Sequence (30xx,0826) is not present. Only a single Item shall be included in this sequence.
>>*Include 'SOP Instance Reference Macro' Table 10-11*			
>Delivered Radiation Dose Sequence	(30xx,0826)	1C	Delivered doses from former treatments before the current RT Course. Required if Prior RT Course Sequence (30xx,0824) is not present. May be present otherwise. One or more Items shall be included in this sequence. See C.AA.A3.1.2.
>>Delivered Radiation Dose	(30xx,0828)	1	The Dose (in Gray) that was delivered.
>>Conceptual Volume Sequence	(30xx,1346)	1C	References to conceptual volumes which received dose in former treatments. Required if the former dose can be traced back to a conceptual volume. One or more Items shall be included in this sequence.
>>>*Include 'Conceptual Volume Segmentation Reference and Combination Macro' Table C.AA.2.6-1*			
>>Delivered Irradiated Volume Description	(30xx,082C)	1C	A textual description of the volume that received dose in former treatments. Required if Conceptual Volume Sequence (30xx,1346) is not present. May be present otherwise.
RT Course State Sequence	(30xx,0830)	1	Defines the state of this RT Course. Only a single Item shall be included in this sequence. See C.AA.A3.1.3.

Attribute Name	Tag	Type	Description
>Include 'RT Item State Macro' Table C.AA.2.3-1			*Defined CID for the Assertion Code Sequence (30xx,50A0) shall be SUP147043.* *See C.AA.A3.1.3.*

2 C.AA.A3.1   RT Course Attribute Description

C.AA.A3.1.1   RT Course Scope Indicator

4 It is generally assumed that there is only one 'active' RT Course SOP Instance at a given time, for a given 'course' of treatment. However, this is not guaranteed by technical means, and therefore it is
6 the specific configuration of devices and the workflow definition within a department that defines the roles with respect to the RT Course (for further information see DICOM Part 17, Section ZZ.2). Within
8 this paradigm, a device may know that it has only a partial knowledge of all involved SOP Instances (e.g. only that knowledge needed to perform a specific activity), and therefore deliberately annotate
10 an RT Course with a RT Course Scope Indicator (30xx,0804) of PARTIAL.

In absence of a value no statement can be made about the scope of the current RT Course SOP
12 instance.

C.AA.A3.1.2   Delivered Radiation Dose Sequence

14 The Delivered Radiation Dose Sequence (30xx,0826) in the Prior Treatment Sequence is intended to contain information about treatments that have not been under the regime of a former RT Course,
16 and therefore have to be recorded explicitly. This shall address especially the situation of denoting former treatments handled by an application which does not support the 2nd generation RT IODs.

18 C.AA.A3.1.3   RT Course State Sequence

The value of this attribute identifies the state of the RT Course itself. The state of referenced SOP
20 instances is part of the Associated Instance State Sequence (30xx,0903).
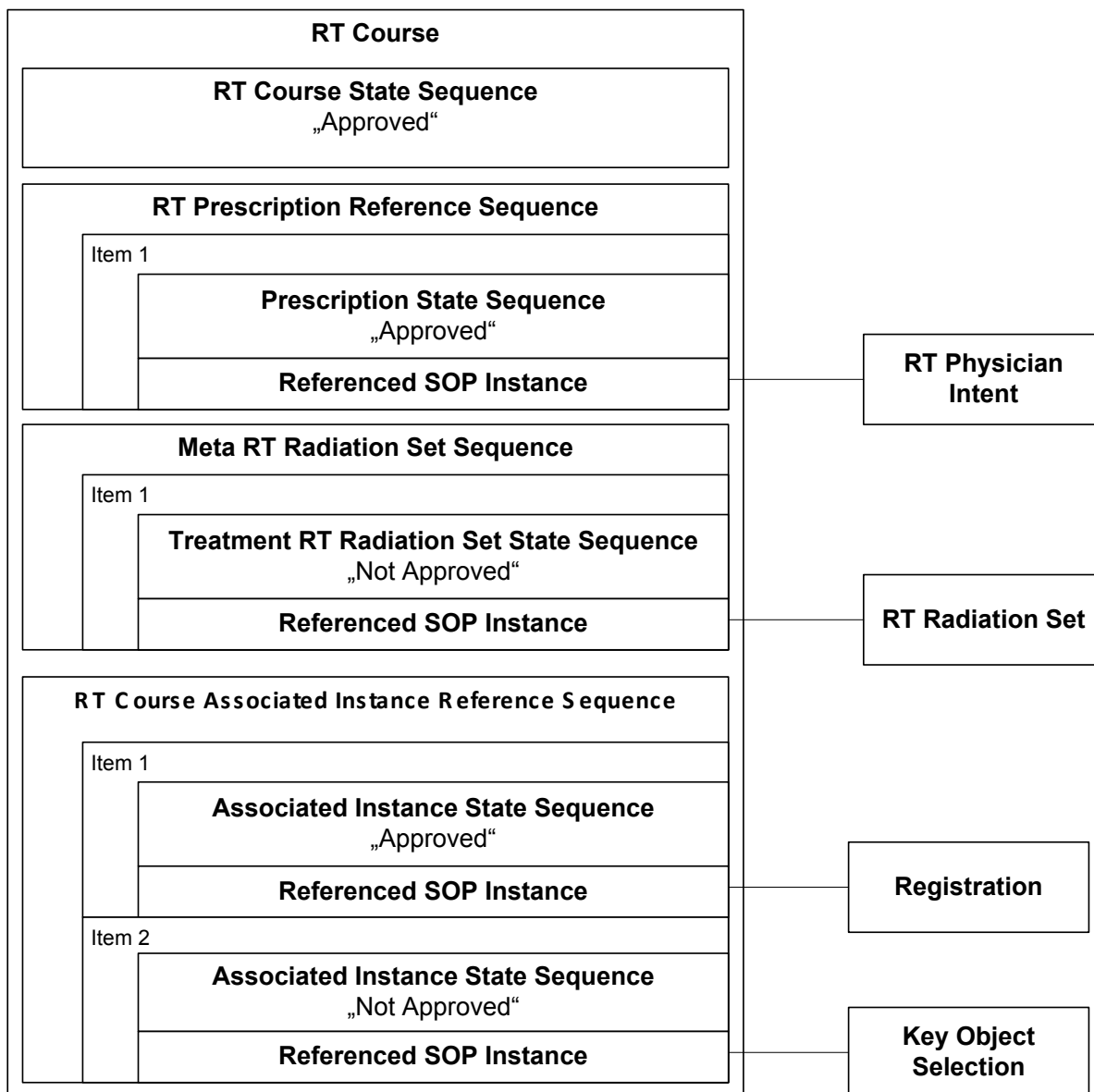
2 **Figure C.AA.A3-1**
State of RT Course and Associated Instances

4   The transitions between states are not defined in DICOM.

The meaning of the following codes is specialized in the RT Course State Sequence.

6   A value of (S147652, 99SUP147, "Approved") means that the information in this instance of the RT
Course SOP instance is approved.

8   **C.AA.A4   RT Prescription Reference Module**

The RT Prescription Reference Module contains information about the state of prescriptions and the
10 intended phase relationship of treatment delivery.

Table C.AA.A4-1
2   **RT PRESCRIPTION REFERENCE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Description
RT Prescription Reference Sequence	(30xx,0860)	1	List of referenced Prescriptions. One or more Items shall be included in this sequence.
>RT Prescription Reference Index	(30xx,0861)	1	Index of the Item in the sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced RT Prescription Sequence	(30xx,0864)	1	Reference to a prescription within an RT Physician Intent SOP Instance. Only a single Item shall be included in this sequence.
>>Include 'SOP Instance Reference Macro' Table 10-11			
>>Referenced RT Prescription Index	(30xx,0148)	1	The value of RT Prescription Index (30xx,0118) corresponding to the prescription in the referenced SOP Instance.
>Prescription State Sequence	(30xx,0866)	1	State of the prescription. Only a single Item shall be included in this sequence.
>>Include 'RT Item State Macro' Table C.AA.2.3-1			*Defined CID for the Assertion Code Sequence (30xx,50A0) shall be SUP147043.* *See C.AA.A4.1.1.*
>Referenced Treatment Phase Sequence	(30xx,0870)	1C	Reference to Treatment Phases prescribed by this prescription. Required if Treatment Phase Sequence (30xx,0880) is present in the RT Treatment Phase module of this SOP instance. One or more Items shall be included in this sequence.
>>Referenced Treatment Phase Index	(30xx,0146)	1	The value of Treatment Phase Index (30xx,0116) corresponding to the referenced treatment phase.
>Referenced RT Segment Annotation Sequence	(30xx,0874)	2	Reference to RT Segment Annotation SOP Instances on which this prescription is based. Zero or more Items shall be included in this sequence.
>>Include 'SOP Instance Reference Macro' Table 10-11			

C.AA.A4.1   RT Prescription Reference Attribute Description

2   **C.AA.A4.1.1   RT Item State Macro Meanings**

The meaning of the following codes is specialized in the Prescription State Sequence.

4   A value of (S147652, 99SUP147, "Approved") means that the prescription has been approved. It is ready to be used for treatment planning.

6   A value of (S147653, 99SUP147, "Rejected") means that the prescription has been rejected and shall not be used for treatment planning.

8

C.AA.A5   RT Treatment Phase Module

10   This module defines RT Treatment Phases and the time order in which RT Radiation Sets are treated in relation to each other.

12   **Table C.AA.A5-1**
                          RT TREATMENT PHASE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Treatment Phase Sequence	(30xx,0880)	1	Treatment Phases for this SOP instance. One or more Items shall be included in this sequence.
>Include 'RT Treatment Phase Macro' Table C.AA.2.34-1			
>RT Treatment Phase State Sequence	(30xx,088A)	1	State of this phase. Only a single Item shall be included in this sequence.
>>Include 'RT Item State Macro' Table C.AA.2.3-1			*Defined CID for the Assertion Code Sequence (30xx,50A0) shall be SUP147043.* *See C.AA.A5.1.1*
Include 'RT Treatment Phase Interval Macro' Table C.AA.2.35-1			

14

C.AA.A5.1   RT Treatment Phase Attribute Description

16   **C.AA.A5.1.1   RT Item State Macro Meanings**

The meaning of the following codes is specialized in the RT Treatment Phase State Sequence.

18   A value of (S147652, 99SUP147, "Approved") means that the treatment phase has been approved. The intended timing is ready to be used for fractionation.

20   A value of (S147653, 99SUP147, "Rejected") means that the current treatment phase has been rejected and shall not be used.

22   **C.AA.A6   RT Radiation Set Reference Module**

The RT Radiation Set Reference Module contains information about multiple radiation sets being
24   prepared, in treatment and finished (discontinued or retired). These radiation sets will typically refer to prescriptions contained in the RT Prescription Reference Module, as being part of the realization of a

certain prescription. The module also contains information about the chronological relation of the
2   radiation sets to each other (subsequent, in parallel, etc.).

Table C.AA.A6-1
4   **RT RADIATION SET REFERENCE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Description
Meta RT Radiation Set Sequence	(30xx,08B0)	1	List of Meta RT Radiation Sets. One or more Items shall be included in this sequence.
>Include 'RT Entity Labeling Macro' Table C.AA.2.1-1			
>Meta RT Radiation Set Index	(30xx,0117)	1	Index of the Meta RT Radiation Set in the sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced RT Prescription Index	(30xx,08C2)	1C	The value of the Prescription Index (30xx,0118) in the RT Prescription Reference Module corresponding to prescription for which this RT Radiation Set is defined. Required if the referenced RT Radiation Set is based on a Physician Intent.
>Referenced Treatment Phase Index	(30xx,08C3)	1C	The value of Treatment Phase Index (30xx,0116) corresponding to the phase to which this Radiation Set belongs. Required if the Treatment Phase Sequence (30xx,0880) is present.
>Radiation Set Start Delay	(30xx,08C6)	1C	The minimum number of days from the beginning of the treatment phase to first day of treatment. See C.AA.A6.1.2 The treatment phase is identified by Referenced Treatment Phase Index (30xx,08C3). Required if Referenced Treatment Phase Index (30xx,08C3) is present.
>Meta RT Radiation Set Relationship Sequence	(30xx,0123)	2	Fraction-based relationship to another Meta RT Radiation Set. Zero or one Item shall be included in this sequence.
>>Referenced Meta RT Radiation Set Index	(30xx,0122)	1	The value of RT Meta Radiation Set Index (30xx,0117) corresponding to the Meta Radiation Set to which the current RT Meta Radiation Set is related.

Attribute Name	Tag	Type	Description
>> Fraction-Based Relationship Interval Anchor	(30xx,0984)	1	The anchor point of the Interval specified in the current Meta RT Radiation Set with respect to the related Meta RT Radiation Set referenced by the Referenced Meta RT Radiation Set Index (30xx,0122). Enumerated Values: START: The interval is specified with respect to the start of the related Meta RT Radiation Set. END: The interval is specified with respect to the end of the related Meta RT Radiation Set.
>>Number of Fractions	(30xx,0972)	1	The interval expressed in number of fractions. The Fraction-Based Relationship Interval Anchor (30xx,0984) establishes the anchor point where the interval is tied to. A value of 0 means, that the current Meta RT Radiation Set starts simultaneously with the anchor of the related Meta RT Radiation Set. If Fraction-Based Relationship Interval Anchor (30xx,0984)equals START, this is the number of fractions after the first fraction of the delivery of the referenced RT Meta Radiation Set , when the delivery of the current RT Meta Radiation Set should start. If Fraction-Based Relationship Interval Anchor (30xx,0984) equals END, this is the number of fractions prior to the last fraction of the delivery of the referenced RT Meta Radiation Set, when the delivery of the current RT Meta Radiation Set should start. See TBD (diagrams)
>Pre-treatment RT Radiation Set Reference Sequence	(30xx,08CA)	1C	Referenced Pre-treatment RT Radiation Sets that have been used in developing the final Treatment RT Radiation sets. Required if Radiation Sets have been used to prepare the final Treatment RT Radiation sets. One or more Items shall be included in this sequence.
>>Include 'SOP Instance Reference Macro' Table 10-11			

Attribute Name	Tag	Type	Description
>>Pre-treatment RT Radiation Set Purpose Code Sequence	(30xx,08CB)	1	Defines the purpose of the referenced RT Pre-treatment RT Radiation Set, in preparation of the current treatment. Only a single Item shall be included in this sequence.
>>>*Include 'Code Sequence Macro' Table 8.8-1*			*Defined CID SUP147018.*
>>Referenced RT Segment Annotation Sequence	(30xx,0874)	1	Referenced RT Segment Annotation SOP Instances which have been used during definition of the RT Radiation Set. One or more Items shall be included in this sequence.
>>>*Include 'SOP Instance Reference Macro' Table 10-11*			
>>>Conceptual Volume State Sequence	(30xx,08CC)	2	States associated with the Conceptual Volumes defined in this Referenced RT Segment Annotation Sequence (30xx,0874) Item.. An Item shall be present for each.Conceptual Volume for which a state is defined by a clinician. Zero or more Items shall be included in this sequence.
>>>>Conceptual Volume UID	(30xx,1301)	1	The unique identifier of the Conceptual Volume.
>>>>*Include 'RT Item State Macro' Table C.AA.2.3-1*			*Defined CID for the Assertion Code Sequence (30xx,50A0) shall be SUP147043.*
>>RT Radiation Set State Sequence	(30xx,08C8)	1	Defines the state of this Pre-Treatment RT Radiation Set. Only a single Item shall be included in this sequence.
>>>*Include 'RT Item State Macro' Table C.AA.2.3-1*			*Defined CID for the Assertion Code Sequence (30xx,50A0) shall be SUP147043.* *See C.AA.A6.1.1*
>Treatment RT Radiation Set Reference Sequence	(30xx,08F2)	2	Referenced RT Radiation Sets in this Meta RT Radiation Set. Zero or more Items shall be included in this sequence. See Note 1.
>>*Include 'SOP Instance Reference Macro' Table 10-11*			
>>Treatment RT Radiation Set Sequence Number	(30xx,08F4)	1	The order this radiation set was added to this sequence.

Attribute Name	Tag	Type	Description
>>Treatment RT Radiation Set State Sequence	(30xx,08F6)	1	The state of this Radiation Set. Only a single Item shall be included in this sequence.
>>>Include 'RT Item State Macro' Table C.AA.2.3-1			*Defined CID for the Assertion Code Sequence (30xx,50A0) shall be SUP147043.* *See C.AA.A6.1.1*
>>Treatment RT Radiation Set Operation State Sequence	(30xx,08F8)	1	The operation state of this Radiation Set. Only a single Item shall be included in this sequence. Zero or one item in the enclosing Treatment RT Radiation Set Reference Sequence (30xx,08F2) shall have a value of IN PROGRESS for RT Operation State (30xx,5051).
>>>Include 'RT Operation State Macro' Table C.AA.2.4-1			
>>Referenced RT Radiation Record Sequence	(30xx,08FF)	2C	The RT Radiation Records, which have been created in the course of delivery. Zero or more Items shall be included in this sequence.
>>>Include 'SOP Instance Reference Macro' Table 10-11			
>>Treatment RT Radiation Set Sequence	(30xx,08FA)	1C	==The relation to a previously retired Treatment RT Radiation Set within this Treatment RT Radiation Set Reference Sequence (30xx,08F2) to denote the reason for retiring the referenced Treatment RT Radiation Set.== ==Required if this item is not the first Radiation Set in the order as defined by the== Treatment RT Radiation Set Sequence Number (30xx,08F4)==.== ==Only a single Item shall be included in this sequence.==
>>>Treatment RT Radiation Set Sequence Number	(30xx,08F4)	1	References the previous Treatment RT Radiation Set identified by the Treatment RT Radiation Set Sequence Number (30xx,08F4) within the RT Treatment RT Radiation Set Reference Sequence (30xx,08F2). References to other Meta RT Radiation Sets are not permitted. Defines the previous Treatment RT Radiation Set that was altered.

Attribute Name	Tag	Type	Description
>>>Treatment RT Radiation Set Alteration Type Sequence	(30xx,08FC)	1C	Defines the type of changes. Required if Treatment Radiation Set referenced by Treatment RT Radiation Set Sequence Number (30xx,08F4) was altered. ==Zero== or more Items shall be included in this sequence.
>>>>*Include 'Code Sequence Macro Table 8.8-1*			*Defined CID SUP147014.*
>>>Treatment RT Radiation Set Change Description	(30xx,08FE)	2	User-defined description of the change to the RT Radiation Set.

2   Notes: 1. The Treatment RT Radiation Set Reference Sequence (30xx,08F2) supports versioning of
radiation sets. Higher numbers in the Treatment RT Radiation Set Sequence Number (30xx,08F4)
4   denote RT Radiation Set references that have been added later. See Treatment RT Radiation Set
State Sequence (30xx,08F6) to determine the state information of the Treatment Radiation Set. See
6   Treatment Phases (==blablabla==) for different treatment phases, different treatment targets,
fractionation patterns, etc are not covered within this sequence but by Treatment Phases.

8

C.AA.A6.1   RT Radiation Set Reference Attribute Description

10 ### C.AA.A6.1.1   RT Item State Macro Meanings

The meaning of the following codes is specialized in the RT Radiation Set State Sequence of the Pre-
12 Treatment RT Radiation Set Sequence.

- A value of (S147651, 99SUP147, "Reviewed") means, that the Radiation Set has been reviewed
14   for use to define initial geometric setup for the planning step.

- A value of (S147652, 99SUP147, "Approved") means, that the Radiation Set is approved to be
16   used to define initial geometric setup for the planning step.

- A value of (S147653, 99SUP147, "Rejected") means, that the Radiation Set has been rejected
18   and shall not be used as planning input.

The meaning of the following codes is specialized in the Treatment RT Radiation Set Sequence.

20 - A value of (S147651, 99SUP147, "Reviewed") means, that the Radiation Set has been reviewed
for use for treatment.

22 - A value of (S147652, 99SUP147, "Approved") means, that the Radiation Set is ready for
treatment.

24 - A value of (S147653, 99SUP147, "Rejected") means, that the Radiation Set shall not be used for
treatment.

26 ### C.AA.A6.1.2   Radiation Set Start Delay

C.AA.A6.1.2.1 Radiation Set Start Delay Overview

28 The Radiation Set Start Delay (30xx,08C6) describes the minimum delay in days after the beginning
of the treatment phase. Treatment will be on next available non-zero day of the fractionation pattern.

2 The Radiation Set Start Delay (30xx,08C6) belongs to the Radiation Set Reference module, while the Fraction Pattern is defined at the Radiation Set level. The Radiation Set Start Delay (30xx,08C6) is counted from the Treatment Phase start. The Treatment Phase groups one or more Radiation Sets.

4 Hence, Radiation Set Start Delay (30xx,08C6) can be used to individually shift Radiation Sets within their Treatment Phase.

```
           ┌──────────────┐                              ┌──────────────┐
           │ RT Course IOD│                              │ RT Radiation │
           │              │                              │    IOD       │
           └──────────────┘                              └──────────────┘
              ▲      ▲                                          ▲
             /        \                                         │
┌─────────────────┐  ┌──────────────────┐        ┌──────────────────────────────────┐
│  RT Treatment   │  │  RT Radiation    │        │      RT Radiation Set IOD        │
│  Phase Module   │◄─│  Set Reference   │───────►│                                  │
│                 │  │    Module        │        │  + Fraction Pattern              │
│                 │  │                  │        │  + Number of Fraction Pattern Digits │
│                 │  │  + Radiation Set │        │  Per Day                         │
│                 │  │  Start Delay     │        │  +Repeat Fraction Cycle Length   │
└─────────────────┘  └──────────────────┘        └──────────────────────────────────┘
```

6
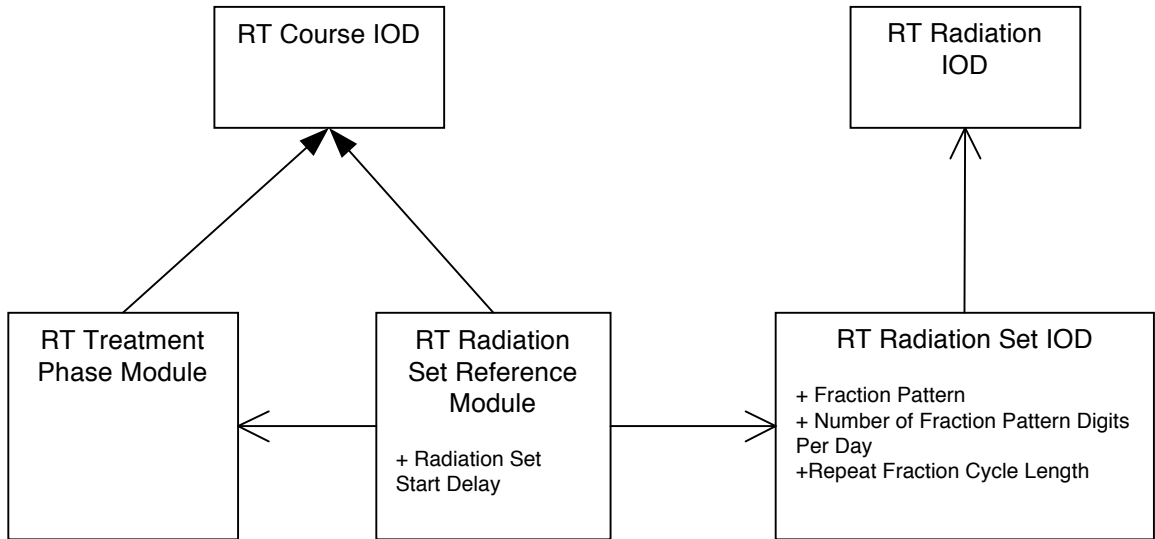
8 If a Fractionation Pattern (300A,007B) contains one or more zeros starting on the week day of the first day following the Radiation Set Start Delay (30xx,08C6), then treatment starts at the first occurrence of 1 in the pattern.

10 **C.AA.A6.1.2.2 Examples of Radiation Set Start Delay**

a) Scenario 1: Single Fraction Each Day

12 Description: First Calender Day of Phase Start is Wednesday. The Delay for Start of Treatment is defined as 1 day.

14 Attributes:

Number of Fraction Pattern Digits per Day = 1

16 Repeat Fraction Cycle Length = 1

Fraction Pattern = 1111100

18 Radiation Set Start Delay = 1

Result: Radiation Set treatment begins Thursday.

Day of the week	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo

Pattern	1	1	1	1	1	0	0	1	1	1	1	1	0	0	1
Phase start: Wednesday			Delay 1 day →												
Actual Treatment			/////	1	1	0	0	1	1	1	1	1	0	0	...

2   Result: Radiation Set treatment begins the next treatment day as defined by the pattern which is Thursday.

4

b) Scenario 2: Single Fraction Every Other Day

6   Description: First Calendar Day of Phase Start is Wednesday. The Delay for Start of Treatment is defined as 3 days. 0 or 1 fractions are scheduled per day, along the pattern 1 fraction on Monday,
8   Wednesday, Friday:

Attributes:

10   Number of Fraction Pattern Digits Per Day = 1

       Repeat Fraction Cycle Length = 1

12   Fraction Pattern = 1010100

       Radiation Set Start Delay = 3

Day of the week	**Mo**	**Tu**	**We**	**Th**	**Fr**	**Sa**	**Su**	**Mo**	**Tu**	**We**	**Th**	**Fr**	**Sa**	**Su**	**M**
Pattern	1	0	1	0	1	0	0	1	0	1	0	1	0	0	1
Phase start: Wednesday			Delay 3 days ————→												
Actual Treatment			/////	/////	/////	0	0	1	0	1	0	1	0	0	...

14

Result: Radiation Set treatment begins the next treatment day as defined by the pattern after
16   Saturday which is Monday of the following week.

c) Scenario 3: Varying Fractions Every Other Day

18   Description: Same as Scenario 2, but with varying fractions per day

       Note: Readers should not focus on the clinical relevance of the pattern in this scenario. The scenario is
20   provided as follows to illustrate the purpose of the attributes.
       Attributes:

22   Number of Fraction Pattern Digits Per Day = 2

       Repeat Fraction Cycle Length = 1

24   Fraction Pattern = 01001100100000

       Radiation Set Start Delay = 3

Day of the week	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	M
Pattern	01	00	11	00	10	00	00	01	00	11	00	10	00	00	01
Phase start: Wednesday			Delay 3 days												
Actual Treatment			▨	▨	▨	00	00	01	00	11	00	10	00	00	…

2   Result: Radiation Set treatment begins the next treatment day as defined by the pattern after Saturday which is Monday afternoon of the following week.

4

C.AA.A7   RT Course Associated Instance Reference Module

6   The RT Course Associated Instance Reference Module contains information about other instances relevant to this course. This list of references provides the facility to reference SOP instances, which

8   are not referenced directly in the RT Course IOD. The Instance Reference Purpose Code Sequence (30xx,0901) annotates the purpose the references play in the scope of an RT Course.

10   **Table C.AA.A7-1**
                 RT COURSE ASSOCIATED INSTANCE REFERENCE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
RT Course Associated Instance Reference Sequence	(30xx,0900)	1	References to SOP instances supporting specific use cases. One or more Items shall be included in this sequence.
>Associated Instance State Sequence	(30xx,0903)	1C	The state of this associated instance. Required if this instance has a state in the context of this RT Course. Only a single Item shall be included in this sequence.
>>Include 'RT Item State Macro' Table C.AA.2.3-1			*Defined CID for the Assertion Code Sequence (30xx,50A0) shall be SUP147043.*
>Purpose of Reference Code Sequence	(0040,A170)	1	The purpose of the RT Course Associated Instance Reference Sequence item. Only a single Item shall be included in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1			*Defined CID SUP147020.*
>Include 'SOP Instance Reference Macro' Table 10-11			

12

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 Course Storage	1.2.840.10008.5.1.4.1.1.481.XN.1	

4

Add the following to PS3.4, Table I.4-1

2

Table I.4-1 Media Storage Standard SOP Classes

SOP Class Name	SOP Class UID	IOD Specification
RT Course Storage	1.2.840.10008.5.1.4.1.1.481.XN.1	RT Course

4

Part 6 Addendum

2 | **Add the following data elements to PS3.6:**

4 **6   REGISTRY OF DICOM DATA ELEMENTS**

[Editorial Note: The content of this chapter is currently only part of Supplement 147, rev. 43, where
6 the table of attributes is already separated between those attributes that will be part of Supplement 147
and those that will be moved over to this document, once Supplement 147 is ready for Public
8 comment.]

Add the following to PS3.6 Annex A:

2

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

4
                                        Table A-1
                                        UID VALUES

6

UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.5.1.4.1.1.481.XN.1	RT Course Storage	SOP Class	PS 3.4

8

2   **Add the following data elements to PS3.6, Annex A:**

Table A-3
4   **CONTEXT GROUP UID VALUES**

Context UID	Context Identifier	Context Group Name
1.2.840.10008.6.1.FFF.10	SUP147010	Beam Limiting Device Types
1.2.840.10008.6.1.FFF.11	SUP147011	Radiotherapy Robotic Paths
1.2.840.10008.6.1.FFF.14	SUP147014	Treatment RT Radiation Set Alteration Types
1.2.840.10008.6.1.FFF.15	SUP147015	Treatment Termination Reasons
1.2.840.10008.6.1.FFF.16	SUP147016	Compensator Device Types
1.2.840.10008.6.1.FFF.17	SUP147017	Radiotherapy Treatment Machine Modes
1.2.840.10008.6.1.FFF.18	SUP147018	Pre-Treatment RT Radiation Set Purpose
1.2.840.10008.6.1.FFF.20	SUP147020	Instance Reference Purposes
1.2.840.10008.6.1.FFF.21	SUP147021	Patient Setup Techniques
1.2.840.10008.6.1.FFF.23	SUP147023	Shielding Device Types
1.2.840.10008.6.1.FFF.24	SUP147024	Setup Devices
1.2.840.10008.6.1.FFF.26	SUP147026	Dose Statistics
1.2.840.10008.6.1.FFF.27	SUP147027	Fixed Beam Limiting Device Types
1.2.840.10008.6.1.FFF.28	SUP147028	Radiotherapy Wedge Types
1.2.840.10008.6.1.FFF.30	SUP147030	General Accessory Device Types
1.2.840.10008.6.1.FFF.35	SUP147035	Effective Dose Method Code Definition
1.2.840.10008.6.1.FFF.36	SUP147036	Purpose of Referenced Dose Calculation Annotation Object
1.2.840.10008.6.1.FFF.37	SUP147037	Dose Data Source Measurement Definition

1.2.840.10008.6.1.FFF.39	SUP147039	Dose Histogram Spatial Unit Definition
1.2.840.10008.6.1.FFF.41	SUP147041	Dose Algorithm Class
1.2.840.10008.6.1.FFF.43	SUP147043	RT Item States
1.2.840.10008.6.1.FFF.44	SUP147044	RT Operation States
1.2.840.10008.6.1.FFF.48	SUP147048	Revised value
1.2.840.10008.6.1.FFF.49	SUP147049	Radiotherapy General Workitem Definition
1.2.840.10008.6.1.FFF.50	SUP147050	Beam Mode Type Definition
1.2.840.10008.6.1.FFF.51	SUP147051	Delivery Rate Unit Definition
1.2.840.10008.6.1.FFF.54	SUP147054	Treatment Delivery Device Type
1.2.840.10008.6.1.FFF.55	SUP147055	Dosimeter Unit Definition
1.2.840.10008.6.1.FFF.56	SUP147056	Treatment Session Sign-Off
1.2.840.10008.6.1.FFF.65	SUP147065	Radiotherapy Dose Real World Units

2

Part 16 Addendum

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

4 [Editorial Note: The content of this chapter is currently only part of Supplement 147, rev. 43, where the CID tables are already separted between those that will be part of Supplement 147 and those that
6 will be moved over to this document, once Supplement 147 is ready for Public comment.]

8

> **Add the following to the table in PS3.16, Annex D:**

2

ANNEX D   DICOM CONTROLLED TERMINOLOGY DEFINITIONS (NORMATIVE)

4

[Editorial Note: The content of this chapter is currently only part of Supplement 147, rev. 43, where the definitions are already separated between those that will be part of Supplement 147 and those that will be moved over to this document, once Supplement 147 is ready for Public comment.]