ELEKTA

Elekta Ltd

DICOM Conformance Statement

For

Integrity™

Release 3.1

Document Number:	4513 364 5778
Version:	3.1
Date:	08 August 2012

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1. Introduction

This chapter provides general information about the purpose, scope and contents of this Conformance Statement. This document is the DICOM conformance statement for Release 3.1 of Integrity™ that supports the Elekta Agility™ head.

1.1 Scope and field of application

The scope of this DICOM Conformance Statement is to facilitate data exchange with equipment of Elekta Limited. This document specifies the compliance to the DICOM standard (formally called the NEMA PS 3.X-1998 standards). It contains a short description of the applications involved and provides technical information about the data exchange capabilities of the equipment. The main elements describing these capabilities are the supported DICOM Service Object Pair (SOP) Classes, Roles, Information Object Definitions (IOD) and Transfer Syntaxes.

The field of application is the integration of the Elekta Oncology Systems equipment into an environment of medical devices.

This Conformance Statement should be read in conjunction with the DICOM standard and its addenda.

1.2 Intended audience

This Conformance Statement is intended for:

- (potential) customers,
- system integrators of medical equipment,
- marketing staff interested in system functionality,
- software designers implementing DICOM interfaces

It is assumed that the reader is familiar with the DICOM standard.

1.3 Contents and structure

The DICOM Conformance Statement is contained in chapter 2 through 7 and follows the contents and structuring requirements of DICOM PS 3.2-1998 Additionally, the Appendices following chapter 7 specify the details of the applied IODs, SCP-specific status codes and extended configuration details.

1.4 Used definitions, terms and abbreviations

- DICOM definitions, terms and abbreviations are used throughout this Conformance Statement. For a description of these, see DICOM PS 3 1998. See also note under 1.5.
- The word Elekta in this document refers to Elekta Limited.
- The term Integrity™ in this document refers to the Elekta Precise Treatment System Product, Release 3.1.

1.5 References

[DICOM PS 3 2007] The Digital Imaging and Communications in Medicine (DICOM) standard:
NEMA PS 3.X (X refers to the part 1 - 13) and Supplements.
National Electrical Manufacturers Association (NEMA) Publication Sales
1300 N. 17th Street, Suite 1847
Rosslyn, Va. 22209, United States of America

The implementation conforms to the DICOM PC 3 2007 standard but will not refer to additional optional attributes referenced in the later standard.

[Ext Int 2007] Digital Accelerator - External Interfaces Manual (45133701937 07). Elekta Limited.

[2TCS-TPS] Elekta – Agility Treatment Planning Information (1021906 01). Elekta Limited.

Important notes to the reader

This Conformance Statement by itself does not guarantee successful interoperability of Elekta equipment with non-Elekta equipment. The user (or user's agent) should be aware of the following issues:

- Scope

The goal of DICOM is to facilitate inter-connectivity rather than interoperability. Interoperability refers to the ability of application functions, distributed over two or more systems, to work successfully together. The integration of medical devices into a networked environment may require application functions that are not specified within the scope of DICOM. Consequently, using only the information provided by this Conformance Statement does not guarantee interoperability of Elekta equipment with non-Elekta equipment. It is the user's responsibility to analyse thoroughly the application requirements and to specify a solution that integrates Elekta equipment with non-Elekta equipment.

- Validation

Elekta equipment has been carefully tested to assure that the actual implementation of the DICOM interface corresponds with this Conformance Statement. Where Elekta equipment is to be linked to non-Elekta equipment, the first step is to compare the relevant Conformance Statements. If the Conformance Statements indicate that successful information exchange should be possible, additional validation tests will be necessary to ensure the functionality, performance, accuracy and stability of prescription data. Prospective users may contact Elekta for up-to-date information regarding available validation status and any known compatibility issues with specific 3rd party vendors. Ultimately, however, it is the responsibility of the user (or user's agent) to specify an appropriate test suite and to carry out additional validation tests on combinations of equipment used within the users environment. In particular integrators should not assume that the Elekta equipment would always be able to detect all forms of invalid data originating from 3rd party equipment.

- New versions of the DICOM Standard

The DICOM Standard will evolve in future to meet the user's growing requirements and to incorporate new features and technologies. Elekta is actively involved in this evolution and plans to adapt its equipment to future versions of the DICOM Standard. In order to do so, Elekta reserves the right to make changes to its products or to discontinue its delivery. The user should ensure that any non-Elekta provider linking to Elekta equipment also adapts to future versions of the DICOM Standard. If not, the incorporation of DICOM enhancements into Elekta equipment may lead to loss of connectivity and/or incompatibility.

2. Implementation Model

Integrity™ is a networked information system comprising Control Systems and Operators Consoles for use with Elekta Linear Accelerators. Dicom for Integrity™ Release 3.1 operates with the local service user database for Prescription Storage only.

2.1 Application Data Flow Diagram

Integrity™ behaves as a single Application Entity (AE). The related Implementation Model is shown in Figure 1.

2.2 Functional definition of Application Entity

Integrity™ application entity acts as Service Class Provider (SCP) of Verification and Storage Service Classes.

2.3 Sequencing of Real-World Activities

Not applicable.

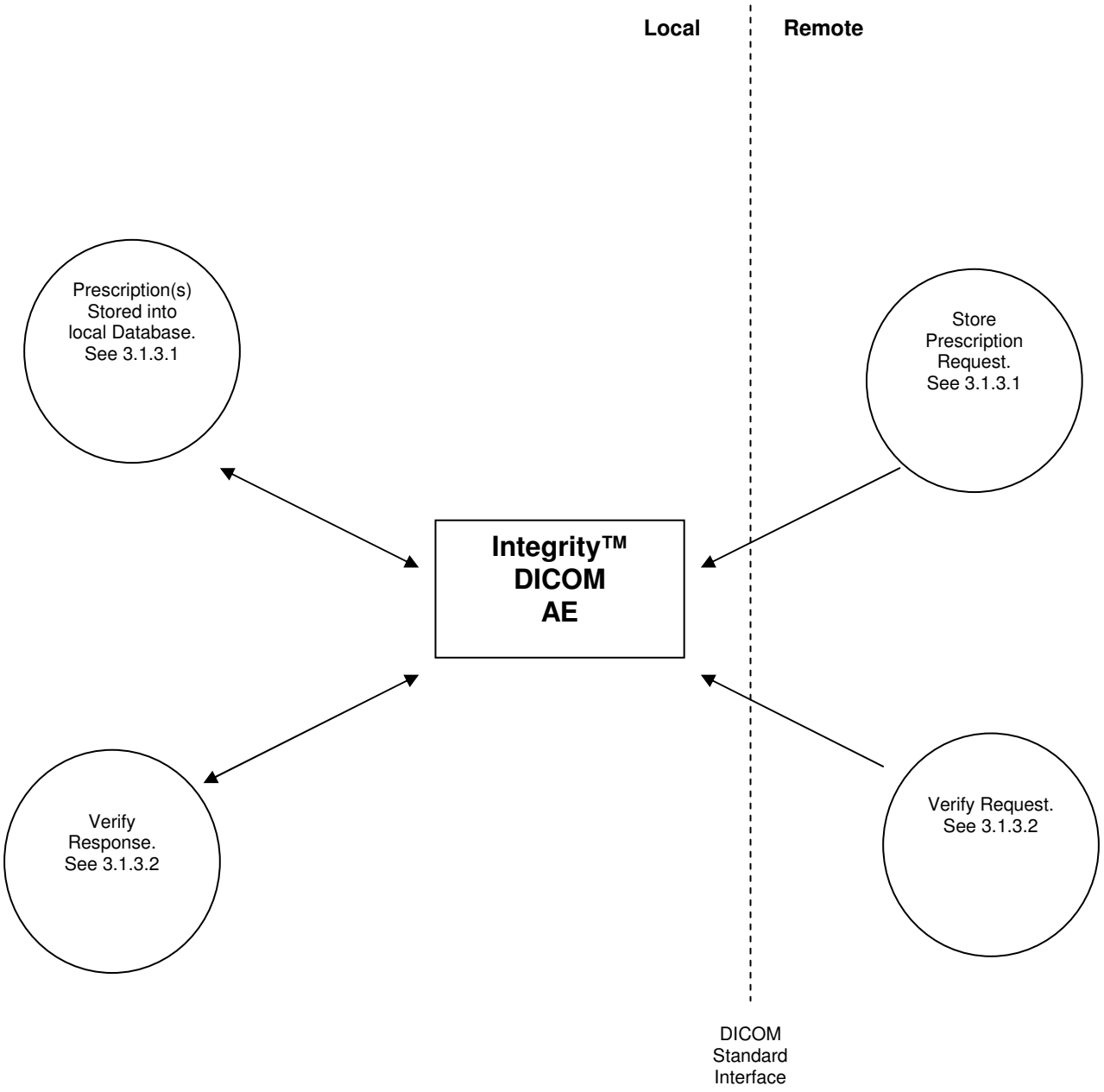

Figure 1 Integrity™ Implementation Model

3. AE Specifications

3.1 Integrity™ AE Specification

Integrity™ Application Entity provides Standard Conformance to the following DICOM V3.0 SOP classes as an SCP:

Table 1 SOP Classes supported by Integrity™ as SCP

SOP Class Name	UID
RT Plan Storage - STORE	1.2.840.10008.5.1.4.1.1.481.5
Verification	1.2.840.10008.1.1

3.1.1 Association Establishment Policies

3.1.1.1 General

The maximum PDU size for Integrity™ is configurable from a minimum of 1024 bytes to a maximum of 31000 bytes. (The default is 16K = 16384 bytes).

3.1.1.2 Number of Associations

Integrity™ will support one active association as a Service Class Provider at a time.
The number of simultaneous pending associations supported is configurable. The default is 5.

3.1.1.3 Asynchronous Nature

Integrity™ does not support asynchronous operations and will not perform asynchronous window negotiation.

3.1.1.4 Implementation Identifying Information

Release 3.1.0
The Implementation Class UID is: 1.3.46.423632.129000.3.1.0
The implementation version name is: Integrity_3.1.0

3.1.2 Association Initiation Policy

Integrity™ does not initiate associations.

3.1.3 Association Acceptance Policy

Integrity™ Application Entity accepts associations for the following purposes:

- To allow remote applications to store prescriptions into the Integrity™ service database (see section 3.1.3.1 below)
- To allow remote applications to verify application level communication with Integrity™ (see section 3.1.3.2 below)

Integrity™ may accept association requests from remote stations depending on Integrity™ configuration:

- The Application Entity rejects association requests from unknown applications i.e. applications that offer an unknown “calling AE title”. An application is known if and only if it is defined during configuration of Integrity™.
- The Application Entity rejects association requests that incorrectly address Integrity™ AE, i.e. from applications that offer a wrong “called AE title”. Integrity™ AE title is defined during configuration of the system (See Section 6.1.1).

3.1.3.1 Store Prescriptions into Integrity™ Database

3.1.3.1.1 Associated Real World Activity

Integrity™ accepts associations from remote systems that wish to send RT Plans for storage into the Integrity™ service database.

3.1.3.1.2 Presentation Context Table

Any of the presentation contexts shown in Table 2 below are acceptable:

Table 2 Acceptable Presentation Contexts for Integrity™ RT Plan Storage

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
RT Plan Storage - STORE	1.2.840.10008.5.1.4.1.1.481.5	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
		Explicit VR Big Endian	1.2.840.10008.1.2.2	SCP	None

3.1.3.1.3 C-STORE SCP Conformance

Integrity™ provides standard conformance.

The AE is a Conformance Level 0 Storage SCP: not all DICOM Type 1 and 2 attributes are stored.

APPENDIX A specifies which attributes from the received C-STORE requests are stored for internal Integrity™ use. All other received attributes will be discarded.

APPENDIX B lists the specific C-STORE response status codes returned by the AE.

The duration of the storage of the prescription is determined by the operator of Integrity™.

3.1.3.1.4 Presentation Context Acceptance Criterion

Integrity™ accepts all contexts in the intersection of the proposed and acceptable presentation contexts. There is no check for duplicate contexts. Duplicate contexts are accepted.

3.1.3.1.5 Transfer Syntax Selection Policies

Integrity™ prefers its native byte ordering (Little Endian), and will prefer explicit over implicit VR.

3.1.3.2 Verify Application Level Communication

3.1.3.2.1 Associated Real World Activity

Integrity™ accepts associations from systems that wish to verify the application level communication using the C-ECHO command.

3.1.3.2.2 Presentation Context Table

Any of the presentation contexts shown in Table 3 below are acceptable:

Table 3 Acceptable Presentation Contexts for Verification

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
		Explicit VR Big Endian	1.2.840.10008.1.2.2	SCP	None

3.1.3.2.3 C-ECHO SCP Conformance

Integrity™ provides standard conformance.

3.1.3.2.4 Presentation Context Acceptance Criterion

Integrity™ accepts all contexts in the intersection of the proposed and acceptable presentation contexts. There is no check for duplicate contexts. Duplicate contexts are accepted.

3.1.3.2.5 Transfer Syntax Selection Policies

Integrity™ prefers its native byte ordering (Little Endian), and will prefer explicit over implicit VR.

4. Communication Profiles

4.1 Supported Communication Stacks

The Integrity™ application provides DICOM V3.0 TCP/IP Network Communication Support as defined in Part 8 of the DICOM Standard.

4.2 TCP/IP Stack

Integrity™ inherits its TCP/IP stack from the Microsoft Windows XP operating system upon which it executes.

4.3 Physical Media Support

Integrity™ supports Ethernet ISO.8802-3.
On Elekta supplied hardware platforms the connection type provided is 100/10BASE-T (RJ45 twisted pair).

5. Extensions/Specialisations/Privatisations

Not applicable.

6. Configuration

Integrity™ DICOM settings are configured by means of a DICOM-specific tab in the Integrity™ configuration program.

Configuration changes are effective immediately they are committed, and the Elekta DicomSCP service is restarted.

Configuration is intended to be performed by Elekta service engineers only.

6.1 AE Title/Presentation Address mapping

6.1.1 Local AE Titles and Presentation Addresses

The local Application Entity Title is configurable. The default is “EOS_RTD”

The listen port number is configurable. The default is 104.

6.1.2 Remote AE Titles and Presentation Addresses

All remote applications that wish to communicate with Integrity™ must be defined at Integrity™ DICOM configuration time.

The following information must be provided for release 3.1.0:

- The remote AE Title.

The IP address and Host name are no longer required.

6.2 Configurable Parameters

6.2.1 Communication Parameters

- The Maximum PDU size is configurable.
- The maximum number of simultaneous pending associations is configurable.
- Dicom Upper Layer Timeouts are configurable.

6.2.2 Integrity™ Attribute Mapping

- The mapping of certain Integrity™ Prescription parameters from attributes in received RT Plan storage requests can be explicitly disabled through configuration. (See Appendix C).

7. Support of Extended Character Sets

None.

APPENDIX A Applied RT Plan IOD and Mapping to Integrity™ Database

A.1 Import of RT Plan Prescriptions

The modules selected from the RT Plan IOD of DICOM for prescription import are given in Table 4 below. If a module is not listed, none of the attributes in that module is stored by Integrity™.

Table 4 Applied Modules in the RT Plan IOD for Import (SCP Role)

IE	Module	Usage
Patient	Patient	M
Study	General Study	M
Series	RT Series	M
Equipment	General Equipment	M
Plan	RT General Plan	M
	RT Prescription	U
	RT Tolerance Tables	U
	RT Patient Setup	U
	RT Fraction Scheme	U
	RT Beams	C
	Approval	U
	SOP Common	M

A.2 RT Plan IOD Modules

Table 5 to Table 17 below specify, for each of the applied modules above, the attributes stored by Integrity™, further details of mapping onto the Integrity™ database, and any attribute specific constraints applicable to their use. Attributes that are completely **ignored** by Integrity™ are shown shaded.

Ignored attributes are not stored into the Integrity™ service database. **However, all DICOM prescriptions must conform to the DICOM standard.** If any part of a prescription does not conform to the standard then that prescription is not saved into the database and the storage request is rejected. Thus, Integrity™ performs validation of the entire applied IOD. I.e. where attributes irrelevant to Integrity™ are included in a message, they must still have values that are valid according to the DICOM standard. Storage requests containing invalid attributes will be REJECTED. **(See** Table 18**, Status Code A901).**

Note that Integrity™ configuration settings may determine whether certain attributes are actually used to map to Integrity™ parameters (see Appendix C).

Table 5 RT Plan Storage SOP Class (SCP) – Patient Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Patients Name	(0010,0010)	PN 1	2	Treated as Type 1 attribute. See Note I.
Patient ID	(0010, 0020)	LO 1	2	Treated as Type 1 attribute. See Note I.
Patient's Birth Date	(0010, 0030)	DA 1	2	Ignored
Patients Sex	(0010, 0040)	CS 1	2	
Referenced Patient Sequence	(0008, 1120)	SQ 1	3	
>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	
Patient's Birth Time	(0010, 0032)	TM 1	3	
Other Patient IDs	(0010, 1000)	LO 1-N	3	
Other Patient Names	(0010, 1001)	PN 1-N	3	
Ethnic Group	(0010, 2160)	SH 1	3	
Patient Comments	(0010, 4000)	LT 1	3	

Note I Handling of Empty Patient Identification Attributes

The Patient ID (0010, 0020) and Patient Name (0010, 0010) attributes of the Patient Module are specified by DICOM as Type 2 and so may legally have zero length.

As a safety measure, however, **Integrity™** treats these attributes as Type 1 and will REJECT any RT Plan Storage request containing zero length values for these attributes. **(See Table 18, Status Code C001)**.

The Patient ID is used in conjunction with the Plan Label to make up the Beam sequence name in Service mode. It is therefore important to provide adequate information in these fields (See Note V).

The 'Patients Name' field (0010, 0010) is a multipart string comprising:
FamilyName^GivenName^MiddleName^NamePrefix^NameSuffix,
where any (but for RTD not all) of the components may be omitted.

Table 6 RT Plan Storage SOP Class (SCP) – General Study Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Study Instance UID	(0020, 000D)	UI 1	1	Logged to Dicom Plan Information record if present. See Note III * Up to 5 values stored
Study Date	(0008, 0020)	DA 1	2	
Study Time	(0008, 0030)	TM 1	2	
Referring Physicians Name	(0008, 0090)	PN 1	2	
Study ID	(0020, 0010)	SH 1	2	
Accession Number	(0008, 0050)	SH 1	2	
Study Description	(0008, 1030)	LO 1	3	
Physician(s) of Record	(0008, 1048)	PN 1-N	3 *	
Name of Physician(s) Reading Study	(0008, 1060)	PN 1-N	3 *	
Referenced Study Sequence	(0008, 1110)	SQ 1	3	Ignored
>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	

Table 7 RT Plan Storage SOP Class (SCP) – RT Series Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Modality	(0008, 0060)	CS 1	1	"RTPLAN" only. **(See Table 18, Status Code A900)**
Series Instance UID	(0020, 000E)	UI 1	1	Logged to Dicom Plan Information record if present. See Note III.
Series Number	(0020, 0011)	IS 1	2	
Series Description	(0008, 103E)	LO 1	3	
Referenced Study Component Sequence	(0008, 1111)	SQ 1	3	Ignored
>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	

Table 8 RT Plan Storage SOP Class (SCP) – General Equipment Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Manufacturer	(0008, 0070)	LO 1	2	Ignored
Institution Name	(0008, 0080)	LO 1	3	
Institution Address	(0008, 0081)	ST 1	3	
Station Name	(0008, 1010)	SH 1	3	
Institutional Department Name	(0008, 1040)	LO 1	3	
Manufacturer's Model Name	(0008, 1090)	LO 1	3	
Device Serial Number	(0018, 1000)	LO 1	3	
Software Version	(0018, 1020)	LO 1-N	3	
Spatial Resolution	(0018, 1050)	DS 1	3	
Date of Last Calibration	(0018, 1200)	DA 1-N	3	
Time of Last Calibration	(0018, 1201)	TM 1-N	3	
Pixel Padding Value	(0028, 0120)	US 1	3	

Table 9 RT Plan Storage SOP Class (SCP) – RT General Plan Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
RT Plan Label	(300A, 0002)	SH 1	1	May be used to derive the name of new Beam sequence. See Note II
RT Plan Name	(300A, 0003)	LO 1	3	Ignored
RT Plan Description	(300A, 0004)	ST 1	3	
Operators Name	(0008, 1070)	PN 1-N	2 *	Logged to Dicom Plan Information record if present. See Note III * Only 1st value stored
RT Plan Date	(300A, 0006)	DA 1	2	
RT Plan Time	(300A, 0007)	TM 1	2	
Treatment Protocols	(300A, 0009)	LO 1-N	3	Ignored
Treatment Intent	(300A, 000A)	CS 1	3	
Treatment Sites	(300A, 000B)	LO 1-N	3	
RT Plan Geometry	(300A, 000C)	CS 1	1	
Referenced Structure Set Sequence	(300C, 0060)	SQ 1	1C	
>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	
Referenced Dose Sequence	(300C, 0080)	SQ 1	3	
>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	
Referenced RT Plan Sequence	(300C, 0002)	SQ 1	3	
>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	
>RT Plan Relationship	(300A, 0055)	CS 1	1C	

Note II Creation of Beam Sequence

The name of the Beam Sequence is derived by combining the RT Plan Label with the Patient ID, see Note V for details.

Note III Dicom Plan Information Record, Dicom Beam Information Record

Certain attributes are identified as being stored to the 'Dicom Plan Information Record' or 'Dicom Beam Information Record'. These are internal areas of the Integrity™ database whose contents are not directly accessible or visible to the end user. Their purpose is primarily to facilitate compatibility with future releases of Integrity™ applications.

Table 10 RT Plan Storage SOP Class (SCP) – RT Prescription Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Prescription Description	(300A, 000E)	ST 1	3	Ignored
Dose Reference Sequence	(300A, 0010)	SQ 1	3	Used to create new Dose Monitoring Points for the new Course of Treatment.
>Dose Reference Number	(300A, 0012)	IS 1	1C	Root of new DMP Name (combined with Dose Reference Description). Number must be unique within sequence. **(See Table 18, Status Code A903)**
>Dose Reference Structure Type	(300A, 0014)	CS 1	1C	Ignored
>Dose Reference Description	(300A, 0016)	LO 1	3	If specified, combined with Dose Reference Number to form new DMP Name (truncated to 64 chars total).
>Referenced ROI Number	(3006, 0084)	IS 1	1C	Ignored
>Dose Reference Point Coordinates	(300A, 0018)	DS 3	1C	
>Nominal Prior Dose	(300A, 001A)	DS 1	3	DMP Adjusted Dose (if non-zero, otherwise zero assumed)
>Dose Reference Type	(300A, 0020)	CS 1	1C	DMP Type
>Constraint Weight	(300A, 0021)	DS 1	3	Ignored
>Delivery Warning Dose	(300A, 0022)	DS 1	3	
>Delivery Maximum Dose	(300A, 0023)	DS 1	3	
>Target Minimum Dose	(300A, 0025)	DS 1	3	
>Target Prescription Dose	(300A, 0026)	DS 1	3	
>Target Maximum Dose	(300A, 0027)	DS 1	3	DMP Max Dose (if Dose Reference Type is ‘TARGET’)
>Target Underdose Volume Fraction	(300A, 0028)	DS 1	3	Ignored
>Organ at Risk Full-volume Dose	(300A, 002A)	DS 1	3	
>Organ at Risk Limit Dose	(300A, 002B)	DS 1	3	
>Organ at Risk Maximum Dose	(300A, 002C)	DS 1	3	DMP Max Dose (if Dose Reference Type is ‘ORGAN_AT_RISK’)
>Organ at Risk Overdose Volume Fraction	(300A, 002D)	DS 1	3	Ignored

NB. For Integrity™ Release 3.1.0, the RT Prescription Module is still processed and any resulting DMPs are stored in the service database; however DMPs are unavailable in Service mode. This module may be completely ignored in a future release of Integrity™.

Table 11 RT Plan Storage SOP Class (SCP) – RT Tolerance Tables Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Tolerance Table Sequence	(300A, 0040)	SQ 1	3	Tolerance Tables. See Appendix C.
>Tolerance Table Number	(300A, 0042)	IS 1	1C	Number must be unique within sequence. **(See Table 18, Status Code A904)**.
>Tolerance Table Label	(300A, 0043)	SH 1	3	If specified, must match name of an existing Integrity™ Tolerance Table. See Note IV. **(See Table 18, Status Code C018)**.
>Gantry Angle Tolerance	(300A, 0044)	DS 1	3	If specified, Tolerance values must match respective values in a corresponding Integrity™ Tolerance Table. See Note IV. **(See Table 18, Status Code C018)**.
>Beam Limiting Device Angle Tolerance	(300A, 0046)	DS 1	3	
>Beam Limiting Device Tolerance Sequence	(300A, 0048)	SQ 1	3	
>>RT Beam Limiting Device Type	(300A, 00B8)	CS 1	1C	
>>Beam Limiting Device Position Tolerance	(300A, 004A)	DS 1	1C	
>Patient Support Angle Tolerance	(300A, 004C)	DS 1	3	
>Table Top Eccentric Angle Tolerance	(300A, 004E)	DS 1	3	
>Table Top Vertical Position Tolerance	(300A, 0051)	DS 1	3	
>Table Top Longitudinal Position Tolerance	(300A, 0052)	DS 1	3	
>Table Top Lateral Position Tolerance	(300A, 0053)	DS 1	3	

Note IV Interpretation of Tolerance Table Data

Integrity™ Tolerance Table names are global within the scope of Integrity™. Mapping from Dicom Tolerance Tables to Integrity™ Tolerance Tables is based on the Tolerance Table Label (300A, 0043):

If the Tolerance Table Label is present but does not map onto the name of an existing Integrity™ Tolerance Table, Integrity™ will REJECT the RT Plan Storage reques**t**.

If the Tolerance Table Label corresponds to an existing Integrity™ Tolerance Table, then any Parameter Tolerance values present in the RT Plan Storage request will be compared with the respective values in the Integrity™ Table. In the case of a match, the existing Tolerance Table will be used for all Prescribed Fields created from Beams that reference this Tolerance Table. In the case of any mismatch of Parameter Tolerances, Integrity™ will REJECT the RT Plan Storage request

If the Tolerance Table Label is not specified, the table in the RT Plan Storage request will be ignored and a status code WARNING ELEMENTS DISCARDED will be returned to the remote application **(See Table 18, Status Code B006)**. In such cases, all Prescribed Fields created from Beams that reference this unlabelled table will be created with UNPRESCRIBED Tolerance Table parameters. It will be necessary for the operator of Integrity™ to specify a valid Integrity™ Tolerance Table for these Prescribed Fields before they become valid for treatment.

Mapping of Tolerance Table data can be disabled by configuration. **(See Table 19 in Appendix C).**

Table 12 RT Plan Storage SOP Class (SCP) – RT Patient Setup Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Patient Setup Sequence	(300A, 0180)	SQ 1	1	Setup Notes. Only created if referenced by Fraction Groups or Beams.
>Patient Setup Number	(300A, 0182)	IS 1	1	Number must be unique within sequence. **(See Table 18, Status Code A905)**.
>Patient Position	(0018, 5100)	CS 1	1C	Setup Note Text (When referenced)
>Patient Additional Position	(300A, 0184)	LO 1	1C	
>Fixation Device Sequence	(300A, 0190)	SQ 1	3	
>>Fixation Device Type	(300A, 0192)	CS 1	1C	Setup Note Text (When referenced)
>>Fixation Device Label	(300A, 0194)	SH 1	2C	
>>Fixation Device Description	(300A, 0196)	ST 1	3	
>>Fixation Device Position	(300A, 0198)	SH 1	3	
>Shielding Device Sequence	(300A, 01A0)	SQ 1	3	
>>Shielding Device Type	(300A, 01A2)	CS 1	1C	Setup Note Text (When referenced)
>>Shielding Device Label	(300A, 01A4)	SH 1	2C	
>>Shielding Device Description	(300A, 01A6)	ST 1	3	
>>Shielding Device Position	(300A, 01A8)	SH 1	3	
>Setup Technique	(300A, 01B0)	CS 1	3	Setup Note Text (When referenced)
>Setup Technique Description	(300A, 01B2)	ST 1	3	
>Setup Device Sequence	(300A, 01B4)	SQ 1	3	
>>Setup Device Type	(300A, 01B6)	CS 1	1C	Setup Note Text (When referenced)
>>Setup Device Label	(300A, 01B8)	SH 1	2C	
>>Setup Device Description	(300A, 01BA)	ST 1	3	
>>Setup Device Parameter	(300A, 01BC)	DS 1	2C	
>>Setup Reference Description	(300A, 01D0)	ST 1	3	Ignored
>Table Top Vertical Setup Displacement	(300A, 01D2)	DS 1	3	
>Table Top Longitudinal Setup Displacement	(300A, 01D4)	DS 1	3	
>Table Top Lateral Setup Displacement	(300A, 01D6)	DS 1	3	

NB. For Integrity™ Release 3.1.0, the RT Patient Setup Module is still processed and any resulting Notes are stored in the service database; however Setup Notes are unavailable in Service mode. This module may be completely ignored in a future release of Integrity™.

Table 13 RT Plan Storage SOP Class (SCP) – RT Fraction Scheme Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Fraction Group Sequence	(300A, 0070)	SQ 1	1	Used to create Beam Sequences.
>Fraction Group Number	(300A, 0071)	IS 1	1	Used as part of Beam Sequence Name. Number must be unique within sequence. **(See Table 18, Status Code A906)**. See Note V.
>Referenced Patient Setup Number	(300C, 006A)	IS 1	3	If specified, must match a Patient Setup Number (300A, 0182) included in the Patient Setup Module. NB Setup Notes are unavailable in Service mode. **(See Table 18, Status Code A905)**.
>Referenced Dose Sequence	(300C, 0080)	SQ 1	3	Ignored
>>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	
>Referenced Dose Reference Sequence	(300C, 0050)	SQ 1	3	
>>Referenced Dose Reference Number	(300C, 0051)	IS 1	1C	
>>Constraint Weight	(300A, 0021)	DS 1	3	
>>Delivery Warning Dose	(300A, 0022)	DS 1	3	
>>Delivery Maximum Dose	(300A, 0023)	DS 1	3	
>>Target Minimum Dose	(300A, 0025)	DS 1	3	
>>Target Prescription Dose	(300A, 0026)	DS 1	3	
>>Target Maximum Dose	(300A, 0027)	DS 1	3	
>>Target Underdose Volume Fraction	(300A, 0028)	DS 1	3	
>>Organ at Risk Full-volume Dose	(300A, 002A)	DS 1	3	
>>Organ at Risk Limit Dose	(300A, 002B)	DS 1	3	
>>Organ at Risk Maximum Dose	(300A, 002C)	DS 1	3	
>>Organ at Risk Overdose Volume Fraction	(300A, 002D)	DS 1	3	
>Number of Fractions Planned	(300A, 0078)	IS 1	2	Ignored. See Note V
>Number of Fractions Per Day	(300A, 0079)	IS 1	3	
>Repeat Fraction Cycle Length	(300A, 007A)	IS 1	3	
>Fraction Pattern	(300A, 007B)	LT 1	3	

(Continued overleaf…)

>Number of Beams	(300A, 0080)	IS 1	1	Number of Beams in Sequence.
>Referenced Beam Sequence	(300C, 0004)	SQ 1	1C	Beams included in Sequence. Beams will be created in the new Sequence in the order in which they appear in the Referenced Beam Sequence. The number of items in the Referenced Beam Sequence must match the Number of Beams attribute (300A, 0080). **(See Table 18, Status Code A906)**.
>>Referenced Beam Number	(300C, 0006)	IS 1	1C	Must match a Beam Number (300A, 00C0) included in the Beam Sequence (300A, 00B0) in the RT Beams Module. **(See Table 18, Status Code A906)**.
>>Beam Dose Specification Point	(300A, 0082)	DS 3	3	Ignored
>>Beam Dose	(300A, 0084)	DS 1	3	If specified, value for a Beam must be the same in all Fraction Groups. **See** Note V**,** Note VI **, Status Code C017)**.
>>Beam Meterset	(300A, 0086)	DS 1	3	If specified, value for a Beam must be the same in all Fraction Groups. Value cannot exceed 9999. **See** Note VI**,** Note VII**,** Note X**Status Code C017)**.
>Number of Brachy Application Setups	(300A, 00A0)	IS 1	1	Must be 0**.** **(See Table 18, Status Code C015)**.
>Referenced Brachy Application Setup Sequence	(300C, 000A)	SQ 1	1C	Ignored
>>Referenced Brachy Application Setup Number	(300C, 000C)	IS 1	1C	
>>Brachy Application Setup Dose Specification Point	(300A, 00A2)	DS 3	3	
>>Brachy Application Setup Dose	(300A, 00A4)	DS 1	3	

Note V Creation of Beam Sequence (Service Mode)

Beam Sequence names are generated according to the following rules.
[DCM] <PatientID(30)>-<Plan.Label(16)> Fr### NNN
Up to a maximum of 64 characters.
Where Fr### is the fraction group number, and
NNN is a sequential counter added to make repeated instances of the same plan unique, hence any given plan can be sent only 999 times.

In the above the figures in round brackets, indicate the reserved space for an element, e.g. <PatientID(16)> means that 16 characters are reserved for the PatientID, however if the PatientID is < 16 characters in length, the element is not padded, but the unused space becomes available to be used by other elements, allocating from left to right.

NB. If the "RT Fraction Scheme Module" is omitted a beam sequence will be generated automatically to contain the imported beams, named according to the rule above.

Note VI Integrity™-Specific Restrictions on Beam Dosimetry & Beam Sequence Groups

In the Dicom data model the Beam Meterset (300A, 0086) is specified as an attribute of the Fraction Group within the Fraction Group Sequence (300A, 0070). This Beam Meterset value is used in conjunction with the Final Cumulative Meterset Weight (300A, 010E) and Cumulative Meterset Weight (300A, 0134) values in the RT Beams Module to derive the actual dosimetric values to be prescribed for a Beam and its Control Points.

Integrity™ data model allows Prescribed Beams to be grouped into one or more Beam Sequences for treatment. In Integrity™ however, the Prescribed MU to be delivered for a given Beam is stored as an attribute of the **Beam**, not of the **Beam Sequence** in which it is being delivered.

Integrity™ will REJECT any RT Plan Storage request if the Beam Meterset (300A, 0086) value for any Referenced Beam Number (300C, 0006) in a Fraction Group is specified to be a different value to that specified in another Fraction Group**.**

I.e. if Beam Meterset is specified for a Beam, it must be specified as the same value in all Fraction Groups in which the Beam appears.

(See Table 18, Status Code C017).

Similarly, in the Dicom model, Beam Dose (300A, 0084) for a Beam is specified as an attribute of the Fraction Group in which the Beam is used. This Beam Dose is used in conjunction with the Cumulative Dose Reference Coefficient (300A, 010C) to derive the dose contribution of a Beam's Control Point to a Dose Reference.

Integrity™ will REJECT any RT Plan Storage request if the Beam Dose (300A, 0084) value for any Referenced Beam Number (300C, 0006) in a Fraction Group is specified to be a different value to that specified in another Fraction Group.

I.e. if Beam Dose is specified for a Beam, it must be specified as the same value in all Fraction Groups in which the Beam appears.

(See Table 18, Status Code C017).

Note VII Handling of Missing Beam Meterset Attributes

The Beam Meterset (300A 0086) attribute is specified by Dicom as Type 3, and is part of an optional IOD module, so it may legally be missing from an RT Plan Storage request.
If this attribute is not present for a particular Referenced Beam Number in any Fraction Group in which the Beam appears, then the Prescribed Field will be created in the Integrity™ database with UNPRESCRIBED MU parameters. It will be necessary for the operator of Integrity™ to enter the Prescribed MU data for the Field and its Control Points before the Field becomes valid for treatment.

Note VIII Handling of Fractions Sequence

No fraction sequences shall be created when the system is running in service mode.

Table 14 RT Plan Storage SOP Class (SCP) – RT Beams Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Beam Sequence	(300A, 00B0)	SQ 1	1	Used to create Prescribed Fields. See Note IX
>Beam Number	(300A, 00C0)	IS 1	1	Combined and used for Prescribed Field Name. Numbers must be unique within sequence. **(See Table 18, Status Code A902). See** Note IX**.**
>Beam Name	(300A, 00C2)	LO 1	3	
>Beam Description	(300A, 00C3)	ST 1	3	Prescribed Field Description
>Beam Type	(300A, 00C4)	CS 1	1	Should be consistent with Control Point contents, i.e. STATIC Beams should prescribe no movements; whereas DYNAMIC Beams should (else a WARNING is returned). **(See Table 18, Status Code B006).**
>Radiation Type	(300A, 00C6)	CS 1	2	"PHOTON" or "ELECTRON" only **(See Table 18, Status Code C005).**
>Primary Fluence Mode Sequence	(3002, 0050)	SQ 1	3	Sequence defining whether the primary fluence of the treatment beam uses a non-standard fluence-shaping. Only a single sequence item is allowed. If omitted, equivalent to Fluence Mode= STANDARD.
>>Fluence Mode	(3002, 0051)	CS 1	1	Describes whether the fluence shaping is the standard mode for the beam or an alternate. Enumerated Values: STANDARD = Uses standard fluence-shaping. NON_STANDARD = Uses a non-standard fluence-shaping mode.
>>Fluence Mode ID	(3002, 0052)	SH 1	1C	Identifier for the specific fluence-shaping mode, value must be FFF if specified. Required if Fluence Mode (3002, 0051) has value NON_STANDARD, otherwise omit this tag. **See** Note XVIII
>Treatment Machine Name	(300A, 00B2)	SH 1	2	Treated as Type 1. Must match an existing Integrity™ Linac Name. **(See Table 18, Status Codes C003,C004)**
>Manufacturer	(0008, 0070)	LO 1	3	Logged to Dicom Beam Information record if present. See Note III.
>Institution Name	(0008, 0080)	LO 1	3	
>Institution Address	(0008, 0081)	ST 1	3	
>Institutional Department Name	(0008, 1040)	LO 1	3	
>Manufacturers Model Name	(0008, 1090)	LO 1	3	
>Device Serial Number	(0018, 1000)	LO 1	3	If specified, must match default Linac ID. **(See Table 18, Status Code C004).**
>Primary Dosimeter Unit	(300A, 00B3)	CS 1	3	If specified, "MU" only, else assumed to be "MU". **Status Code C00A).**
>Referenced Tolerance Table Number	(300C, 00A0)	IS 1	3	If specified, must match a Tolerance Table Number (300A, 0042) included in the Tolerance Table Module. See Note IV. **(See** Note IV**, Status Code A904).**
>Source-Axis Distance	(300A, 00B4)	DS 1	3	Ignored
>Beam Limiting Device Sequence	(300A, 00B6)	SQ 1	1	Must specify a complete set of BLD's. **(See Table 18, Status Code C007).**

>>RT Beam Limiting Device Type	(300A, 00B8)	CS 1	1	Must match capability of the named Treatment Machine (300A, 00B2). See **Note XVII**. **(See Table 18, Status Code C006).**
>>Source to Beam Limiting Device Distance	(300A, 00BA)	DS 1	3	Ignored
>>Number of Leaf/Jaw Pairs	(300A, 00BC)	IS 1	1	40/80 or 1 only (i.e. MLCX or Diaphragms) 80 is only valid for MLCX for an Agility head. **(See Table 18, Status Code C006).**
>>Leaf Position Boundaries	(300A, 00BE)	DS 3-N	2C	Elekta supports two types of multi-element collimators. These values are required to distinguish between the target radiation head type. See **Note XVII**.
>Referenced Patient Setup Number	(300C, 006A)	IS 1	3	If specified, must match a Patient Setup Number (300A, 0182) included in the Patient Setup Module. **(See Table 18, Status Code A905).** Data in referenced Patient Setup will be used as Field Note entries for this Field.

>Referenced Reference Image Sequence	(300C, 0042)	SQ 1	3	Ignored
>>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	
>>Reference Image Number	(300A, 00C8)	IS 1	1C	
>>Start Cumulative Meterset Weight	(300C, 0008)	DS 1	3	
>>End Cumulative Meterset Weight	(300C, 0009)	DS 1	3	
>Planned Verification Image Sequence	(300A, 00CA)	SQ 1	3	
>>Start Cumulative Meterset Weight	(300C, 0008)	DS 1	3	
>>Meterset Exposure	(3002, 0032)	DS 1	3	
>>End Cumulative Meterset Weight	(300C, 0009)	DS 1	3	
>>RT Image Plane	(3002, 000C)	CS 1	3	
>>X-Ray Image receptor Angle	(3002, 000E)	DS 1	3	
>>RT Image Orientation	(3002, 0010)	DS 6	3	
>>RT Image Position	(3002, 0012)	DS 2	3	
>>RT Image SID	(3002, 0026)	DS 1	3	
>>Imaging Device-Specific Acquisition Parameters	(300A, 00CC)	LO 1-N	3	
>>Referenced Reference Image Number	(300C, 0007)	IS 1	3	
>Treatment Delivery Type	(300A, 00CE)	CS 1	3	If specified, “TREATMENT” only, else assumed to be “TREATMENT”. **(See Table 18, Status Code C016).**
>Referenced Dose Sequence	(300C, 0080)	SQ 1	3	Ignored
>>Referenced SOP Class UID	(0008, 1150)	UI 1	1C	
>>Referenced SOP Instance UID	(0008, 1155)	UI 1	1C	
>Number of Wedges	(300A, 00D0)	IS 1	1	1 or 0 only. **(See Table 18, Status Code C00B).**
>Wedge Sequence	(300A, 00D1)	SQ 1	1C	Number of items in the Wedge Sequence must match the Number of Wedges (300A, 00D0) attribute. **(See Table 18, Status Code A902).**
>>Wedge Number	(300A, 00D2)	IS 1	1C	Must be consistent with any specified Referenced Wedge Number (300C, 00C0) used in Wedge Position Sequence (300A, 0116). **(See Table 18, Status Code A902).**
>>Wedge Type	(300A, 00D3)	CS 1	2C	Treated as Type 1. “MOTORIZED” only. **(See Table 18, Status Code C00B).**
>>Wedge ID	(300A, 00D4)	SH 1	3	Ignored
>>Wedge Angle	(300A, 00D5)	IS 1	2C	
>>Wedge Factor	(300A, 00D6)	DS 1	2C	
>>Wedge Orientation	(300A, 00D8)	DS 1	2C	Must be 0 or empty. **(See Table 18, Status Code C00B).**
>>Source to Wedge Tray Distance	(300A, 00DA)	DS 1	3	Ignored

>Number of Compensators	(300A, 00E0)	IS 1	1	Must match number of items in Compensator Sequence (300A, 00E3). **(See Table 18, Status Code A902).** WARNING + Field Note entry if non-zero. See Note XI.
>Total Compensator Tray Factor	(300A, 00E2)	DS 1	3	Ignored. See Note XI
>Compensator Sequence	(300A, 00E3)	SQ 1	1C	
>>Compensator Number	(300A, 00E4)	IS 1	1C	
>>Material ID	(300A, 00E1)	SH 1	2C	
>>Compensator ID	(300A, 00E5)	SH 1	3	
>>Source to Compensator Tray Distance	(300A, 00E6)	DS 1	2C	
>>Compensator Rows	(300A, 00E7)	IS 1	1C	
>>Compensator Columns	(300A, 00E8)	IS 1	1C	
>>Compensator Pixel Spacing	(300A, 00E9)	DS 2	1C	
>>Compensator Position	(300A, 00EA)	DS 2	1C	
>>Compensator Transmission Data	(300A, 00EB)	DS 1-N	1C	
>>Compensator Thickness Data	(300A, 00EC)	DS 1-N	1C	
>Number of Boli	(300A, 00ED)	IS 1	1	Must match number of items in Referenced Bolus Sequence (300A, 00B0). **(See Table 18, Status Code A902).** WARNING + Field Note entry if non-zero. See Note XI
>Referenced Bolus Sequence	(300C, 00B0)	SQ 1	1C	Ignored. See Note XI
>>Referenced ROI Number	(3006, 0084)	IS 1	1C	
>Number of Blocks	(300A, 00F0)	IS 1	1	Must match number of items in Block Sequence (300A, 00F4). (See **Table 18**, Status Code A902). WARNING + Field Note entry if non-zero. See Note XII
>Total Block Tray Factor	(300A, 00F2)	DS 1	3	Ignored
>Block Sequence	(300A, 00F4)	SQ 1	1C	See Appendix C and Note XII.
>>Block Tray ID	(300A, 00F5)	SH 1	3	Interpreted as Shadow Tray ID for prescribed Field. Must be the same for all items in the Block Sequence. See Note XII. **(See Table 18, Status Codes C008, C009).**
>>Source to Block Tray Distance	(300A, 00F6)	DS 1	2C	Ignored. See Note XII
>>Block Type	(300A, 00F8)	CS 1	1C	To Field Note entry. See Note XII
>>Block Divergence	(300A, 00FA)	CS 1	2C	Ignored. See Note XII
>>Block Number	(300A, 00FC)	IS 1	1C	To Field Note entry. See Note XII
>>Block Name	(300A, 00FE)	LO 1	3	To Field Note entry. See Note XII
>>Material ID	(300A, 00E1)	SH 1	2C	Ignored. See Note XII
>>Block Thickness	(300A, 0100)	DS 1	2C	
>>Block Transmission	(300A, 0102)	DS 1	2C	
>>Block Number of Points	(300A, 0104)	IS 1	2C	
>>Block Data	(300A, 0106)	DS 2-2N	2C	

>Applicator Sequence	(300A, 0107)	SQ 1	3	Number of items must be 0 or 1 only. Must only be present if Radiation Type (300A, 00C6) is “ELECTRON”. See Appendix C and Note XIII. **(See Table 18, Status Codes A902,C00D).**
>>Applicator ID	(300A, 0108)	SH 1	1C	Interpreted as Accessory Fitment Code. See Note XIII. **(See Table 18, Status Code C00E).**
>>Applicator Type	(300A, 0109)	CS 1	1C	“ELECTRON_SQUARE”, “ELECTRON_RECT”, “ELECTRON_CIRC”, “ELECTRON_SHORT” (MLCi & MLCi2 only), or “ELECTRON_OPEN” only. Mapped to Accessory Mount. Must be consistent with Field size. See Note XIII. **(See Table 18, Status Code C00E).**
>>Applicator Description	(300A, 010A)	LO 1	3	To Field Note entry. See Note XIII
>Final Cumulative Meterset Weight	(300A, 010E)	DS 1	1C	Used in conjunction with Beam Meterset (300A, 0086) for this Beam (from RT Fraction Scheme Module) to derive Prescribed Field MU. If Beam Meterset is not specified, Prescribed MU for new Field and its Control Points will be set UNPRESCRIBED. See Note VI, Note VII, Note X.
>Number of Control Points	(300A, 0110)	IS 1	1	The number of items in the Control Point Sequence must match the Number of Control Points attribute (300A, 0110). Maximum number of control points is 1000 for Dynamic-MLC/IMAT beams, otherwise 256. Geometric parameters in sequence must be consistent with Beam Type (300A, 00C4). Sequence complexity must comply with product licensing restrictions. **(See Table 18, Status Codes A702, A902, C010, C012).**
>Control Point Sequence	(300A, 0111)	SQ 1	1	
>>Control Point Index	(300A, 0112)	IS 1	1C	Values must start from 0 and increase in steps of 1 only. **(See Table 18, Status Code A902).**
>>Cumulative Meterset Weight	(300A, 0134)	DS 1	2C	Treated as Type 1C. Used in conjunction with Beam Meterset (300A, 0086) for this Beam (from RT Fraction Scheme Module) to derive Control Point MU. If Beam Meterset is not specified, Prescribed MU for new Field and its Control Points will be set UNPRESCRIBED. See Note VI**,** Note VII**,** Note X**, Status Code C013).**
>>Referenced Dose Reference Sequence	(300C, 0050)	SQ 1	3	
>>>Referenced Dose Reference Number	(300C, 0051)	IS 1	1C	If specified, must match a Dose Reference Number (300A, 0012) included in the RT Prescription Module. **(See Table 18, Status Code A903).**

>>>Cumulative Dose Reference Coefficient	(300A, 010C)	DS 1	2C	Used in conjunction with Beam Dose (300A, 0084) for this Beam (from RT Fraction Scheme Module) to derive the Field Dose Contribution from this new Field to the respective Dose Monitoring Point. If Beam Dose is not specified, Dose Contribution will be set to UNPRESCRIBED. See Note VI
>>Nominal Beam Energy	(300A, 0114)	DS 1	3	If specified, must match capability of the named Treatment Machine (300A, 00B2) when combined with the Radiation Type (300A, 00C6). Prescribed value will apply to whole of forthcoming segment. (See Note XV) **(See Table 18, Status Code C005).** If Energy is to change at any time during Beam, it must be prescribed at ALL control points. **(See Table 18, Status Code C01A).** Mapping can be disabled by configuration. **(See Table 19 in Appendix C).**
>>Dose Rate Set	(300A, 0115)	DS 1	3	Nominal dose rate. Prescribed value will apply to whole of forthcoming segment. (See Note XV)
>>Wedge Position Sequence	(300A, 0116)	SQ 1	3	If not specified, and if Number of Wedges (300A, 00D0) is 0, Wedge is assumed to be OUT. If Wedge Position is to change at any time during Beam, Wedge Position Sequence must be specified at EVERY Control Point. **(See Table 18, Status Code C00C).**
>>>Referenced Wedge Number	(300C, 00C0)	IS 1	1C	Must match Wedge Number (300A, 00D2) in Wedge Sequence (300A, 00D1) **(See Table 18, Status Code A902).**
>>>Wedge Position	(300A, 0118)	CS 1	1C	Wedge position (IN, OUT only) will apply to whole of forthcoming segment. (See Note XV)
>>Beam Limiting Device Position Sequence	(300A, 011A)	SQ 1	1C	If present, must specify a complete set of BLDs for the Control Point. See **Note XVII**. **(See Table 18, Status Code C007).**
>>>RT Beam Limiting Device Type	(300A, 00B8)	CS 1	1C	Must match a RT Beam Limiting Device Type (300A, 00B8) in Beam Limiting Device Sequence (300A, 00B6). Each Device Type may appear in the Sequence only once. See **Note XVII**. **(See Table 18, Status Code C006).**
>>>Leaf/Jaw Positions	(300A, 011C)	DS 2-2N	1C	N=1 (for ASYMX, ASYMY, X and Y) or N=40 or 80 (for MLCX). See **Note XVII**. To remove ambiguity in complex beams, if **any** BLD (leaf **or** Jaw) position changes within the control point sequence then the positions for **all** appropriate BLDs should be specified at all control points. **(See Table 18, Status Codes C006, C00F, C010, C019).**

>>Gantry Angle	(300A, 011E)	DS 1	1C	**(See Table 18, Status Code C010).**
>>Gantry Rotation Direction	(300A, 011F)	CS 1	1C	
>>Beam Limiting Device Angle	(300A, 0120)	DS 1	1C	Any resultant movement of collimator between Control Points CANNOT pass through 180 degrees. i.e. sweep is restricted to range 180-270-0-90-180 degrees. Dicom defines the rotation direction as that viewed from the radiation source towards the isocenter. **(See Table 18, Status Codes, C010, C011).**
>>Beam Limiting Device Rotation Direction	(300A, 0121)	CS 1	1C	
>>Patient Support Angle	(300A, 0122)	DS 1	1C	CANNOT change during Control Point Sequence. See Note **XVII** . **(See Table 18, Status Codes C010, C011).**
>>Patient Support Rotation Direction	(300A, 0123)	CS 1	1C	
>>Table Top Eccentric Axis Distance	(300A, 0124)	DS 1	3	Ignored
>>Table Top Eccentric Angle	(300A, 0125)	DS 1	1C	CANNOT change during Control Point Sequence. See Note **XVII** . **(See Table 18, Status Codes C010, C011).**
>>Table Top Eccentric Rotation Direction	(300A, 0126)	CS 1	1C	
>>Table Top Vertical Position	(300A, 0128)	DS 1	2C	
>>Table Top Longitudinal Position	(300A, 0129)	DS 1	2C	
>>Table Top Lateral Position	(300A, 012A)	DS 1	2C	
>>Isocenter Position	(300A, 012C)	DS 3	2C	Ignored
>>Surface Entry Point	(300A, 012E)	DS 3	3	
>>Source to Surface Distance	(300A, 0130)	DS 1	3	If specified at the first control point then it is used for the Focus to Skin Distance (FSD) in the prescribed field. Values at any other control point will be ignored.

Note IX Beam Name Creation

The beam name is built using the rule:

"[DCM: < date/time>]<space><BeamNumber><dot><space><BeamName>"
Up to a maximum of 64 characters, hence BeamName may be truncated.
If BeamName is empty (omitted in DICOM plan) "[DICOM]" is substituted for BeamName above.
The will contain "dd/mm/yy hh:mm:ss" and be accurate to seconds.

example: "[DCM 01/03/05 12:15:45] 1. My Beam Name"
For a beam received at 12:15 and 45 seconds (PM) on the 1st of March 2005

Note X Primary Meterset Resolution and Minimum Radiating Segment Meterset

Integrity™ has a Primary Meterset resolution of 0.1 MU. The Meterset value at any given Control Point will be ROUNDED according to the rules described in Section C.8.8.14.1 of the Dicom Standard PS 3.3.
Integrity™ has a Minimum Radiating Segment Meterset of 1.0 MU. After rounding, non-zero segment Meterset values must be 1.0 MU or greater, otherwise the storage request will be REJECTED. With Integrity™, the Meterset values are rounded to one decimal place and stored in the Integrity™ database to one decimal place. Hence, 0.95 MU is rounded up to 1.0 MU and is valid whilst 0.9499 MU is rounded down to 0.9 MU and is rejected.
In Release 3.1.0 of Integrity™ an exception to the above rules is in force; for Dynamic-MLC and IMAT beams, individual prescribed radiating segments need only contain 0.1 MU provided they can be merged with adjacent segments to form a delivery segment with at least 1.0 MU, for a full description of delivery segments see 'Digital Accelerator - External Interfaces Manual (45133701937 07)' **(See Table 18, Status Code C014).**

Note XI Compensator and Bolus Data Ignored with WARNING

Integrity™ does not store Compensator or Bolus data as part of the prescription.
If either of the attributes Number Of Compensators (300A, 00E) or Number Of Boli (300A, 00ED) is non-zero, the storage request will be accepted but a status code WARNING ELEMENTS DISCARDED will be returned to the remote application .**(See Table 18, Status Code B006).**

Note XII Handling of Block Sequence

Integrity™ stores only a single Shadow Tray ID as part of its Field prescription. Other attributes in the Block Sequence are stored as text in a Field Note entry, corresponding to the Prescribed Field, to alert the operator at treatment time, and a status code WARNING ELEMENTS DISCARDED will be returned to the remote application. **(See Table 18, Status Code B006).**

If Block Tray ID (300A, 00F5) attributes in the Block Sequence are present, they must all have the same value otherwise the storage request will be REJECTED. **(See Table 18, Status Code C009).**

If the specified Block Tray ID (300A, 00F5) can be interpreted as a valid Integrity™ Shadow Tray ID then it will be used as the prescribed Shadow Tray ID for the Field, otherwise the storage request will be REJECTED. **(See Table 18, Status Code C008).**

Mapping of Shadow Tray ID can be disabled by configuration. **(See Table 19 in Appendix C).**

Note XIII Mapping of Applicator Data

Individual Integrity™ Electron Applicators are only valid for use at specific Field sizes. The Applicator Type attribute (300A, 0190) must be one of the supported types and must be consistent with the Field size specified in the first Control Point to define an Integrity™ Applicator valid for treatment. **(See Table 18, Status Code C00E).**

If the specified Applicator ID (300A, 0108) can be interpreted as a valid Integrity™ Accessory Fitment ID then it will be used as the prescribed value for the field, otherwise the storage request will be REJECTED. **(See Table 18, Status Code C00E).**

Additionally the Applicator ID (300A, 0108) and Applicator Description (300A, 010A) attributes will be entered into a Field Note for the corresponding prescribed Field.

Mapping of Applicator data can be disabled by configuration. **(See Table 19 in Appendix C).**

Note XIV Patient Support and Table Top Movements REJECTED

Any storage request that contains any Beam that requires any Table or PSS movement during the Control Point Sequence will be REJECTED. **(See Table 18, Status Code C011).**

Note XV Behaviour of Machine Parameters Between Control Points

During Beam delivery, where the value of scalar geometric parameters is specified to change between successive control-points, it is assumed that the intention is for the parameter value to change linearly with delivered dose.

Geometric rotation directions, Wedge Position (300A, 0118), Nominal Beam Energy (300A, 0114) and Dose Rate Set (300A, 0115) are treated differently. For these parameters, the values specified at a control point will be deemed to apply throughout the forthcoming Beam segment (i.e. until the next control point and irrespective of its value).

Note XVI Special Case handling of Simple Wedged Fields

To maximise interoperability across a range of 3rd party Dicom implementations, and to make optimal use of the motorised wedge feature on Elekta Linacs, Integrity™ will prescribe simple static wedged fields for efficient delivery.

Integrity™ will recognise each of the following cases as a simple wedged field for the purposes of complexity checks and product licensing, and will use the minimum number of delivered Beam segments:

Applicable to Release 4.2 and above

- 3 control points where only Wedge Position changes between 1st and 2nd segment, and effective delivered Meterset is prescribed for both segments.

- 3 control points where only Wedge Position changes, and effective delivered Meterset is zero in either segment (the redundant segment will be discarded and prescribed delivery will be a single segment)
- 4 control points where only Wedge Position changes between 1st and 3rd segments, and effective delivered Meterset is zero for 2nd segment (the redundant segment will be discarded and prescribed delivery will be in two segments).
- Fully wedged simple static or arc fields using 4 control points where :
  - The effective delivered Meterset is non-zero for one segment only.
  - The wedge position changes between the 1st and 3rd segments.
  - The two redundant segments will be discarded and the prescribed delivery will be a single segment.

Note XVII Leaf Boundary values for supported Radiation Head Types.

Integrity™ Release 3.1.0 supports four types of multi-element Radiation Head:

- MLCi (Size 400x400mm, leaf width 10mm) with asymmetric diaphragms ASYMX & ASYMY.
- MLCi2 (Size 400x400mm, leaf width 10mm) with asymmetric diaphragms ASYMX & ASYMY.
- Beam Modulator (Size 210x160mm) with fixed symmetric diaphragms X & Y.
- Agility (Size 400x400mm, leaf width 5mm) with a combination of fixed & asymmetric diaphragms X & ASYMY.

The Leaf Position Boundaries for these radiation head types are summarised in Table 15. The Leaf Position Boundaries tag values (300A, 00BE) specified in a beam must match that for the Linac specified by the Treatment Machine Name tag (300A, 00B2).

Table 15 Leaf Position Boundaries values for supported multi-element Radiation head types.

Multi-element Radiation Head	Number of Leaf pairs	Leaf boundary values (mm)	Notes
MLCi	40	{-200.0 + (10.0*n)} where n = 0,1,..40	Diaphragm positions must be specified for a complete definition of a beam. Otherwise, a storage request will be rejected.
MLCi2	40	{-200.0 + (10.0*n)} where n = 0,1,..40	Diaphragm positions must be specified for a complete definition of a beam. Otherwise, a storage request will be rejected. When licensed, leaves may be prescribed as Interdigitated.
Beam Modulator	40	{ -80.0 + (4.0*n) } where n = 0,1,..40	The diaphragms are at fixed positions. A storage request will be rejected if a beam does not contain the diaphragm positions X={-105.0, 105.0} and Y={-80.0, 80.0}

Agility	80	{-200.0 + (5.0*n)} where n = 0,1,..80	Diaphragm positions must be specified for a complete definition of a beam, including the fixed X diaphragms, which must be prescribed X={-200.0, 200.0} . Otherwise, a storage request will be rejected. When licensed, leaves may be prescribed as Interdigitated.

Special restrictions for the Beam Modulator Head:

- For Photon beams the only valid Beam Limiting Device combination is to specify defined terms X, Y and MLCX.
- For Electron beams the only valid Beam Limiting Device combinations is to specify defined terms X and Y. The diaphragms are interpreted as the applicator nominal field size.
- Leaf positions can be prescribed to be *touching* within the field - i.e. a leaf pair with prescribed leaf separation of zero. The beam modulator cannot realise such a position and in cases of prescribed zero leaf separation there will be an actual non-zero leaf separation and therefore radiation leakage at the prescribed position. Refer to [Ext Int 2007] for details of leaf geometry.
- Leaves closed behind the fixed diaphragms: If both leaves in a pair are prescribed at 110.0 or -110 (outside the field size), the leaves will be converted to the Integrity™ internal representation for a leaf pair closed behind the fixed diaphragms; the Linac control system will choose the fixed diaphragm nearest the actual leaf position at the time of delivery, to minimise leaf movement. If both leaves in a pair are prescribed (touching) at 105.0 or -105.0 (the edges of the field), at delivery the leaves will be retracted under the fixed diaphragms nearest the prescribed position, to minimise leakage.

Special restrictions for the Agility Head:

- For Photon beams the only valid Beam Limiting Device combination is to specify defined terms X, ASYMY and MLCX.
- For Electron beams the only valid Beam Limiting Device combinations is to specify defined terms X and ASYMY. The diaphragms are interpreted as the applicator nominal field size.
- Leaf positions can be prescribed to be *touching* within the field - i.e. a leaf pair with prescribed leaf separation of zero. Agility cannot realise such a position and in cases of prescribed zero leaf separation there will be an actual non-zero leaf separation and therefore radiation leakage at the prescribed position. Refer to [2TCS-TPS] for details of leaf geometry.

Note XVIII Primary Fluence Mode Sequence

The only supported NON_STANDARD fluence mode in Integrity 3.1 is FFF (Flattening Filter Free).
If the Primary Fluence Mode Sequence is omitted, STANDARD Fluence Mode is assumed, meaning Flattened energies will be used. Once a beam has been accepted and stored in the Integrity service database the energy can be changed to any available energy, meaning either flattened or un-flattened energies.

Table 16 RT Plan Storage SOP Class (SCP) – Approval Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
Approval Status	(300E, 0002)	CS 1	1	Logged to Dicom Plan Information record if present.
Review Date	(300E, 0004)	DA 1	2C	
Review Time	(300E, 0005)	TM 1	2C	
Reviewer Name	(300E, 0008)	PN 1	2C	

Table 17 RT Plan Storage SOP Class (SCP) – SOP Common Module

Attribute Name	Tag	VR, VM	DICOM Type	Notes/Constraints
SOP Class UID	(0008, 0016)	UI 1	1	1.840.10008.5.1.4.1.1.481.5 only
SOP Instance UID	(0008, 0018)	UI 1	1	Logged to Dicom Plan Information record if present.
Specific Character Set	(0008, 0005)	CS 1-N	1C	Ignored
Instance Creation Date	(0008, 0012)	DA 1	3	Logged to Dicom Plan Information record if present.
Instance Creation Time	(0008, 0013)	TM 1	3	
Instance Creator UID	(0008, 0014)	UI 1	3	

APPENDIX B C-STORE Response Status Codes

Table 18 below lists the specific status code values returned by Integrity™ in a C-STORE response.
Notes: Integrity™ can be configured to suppress warnings, namely to treat a warning as a success.
A C_STORE request with status code WARNING will have succeeded in transferring the information to the Integrity™ service database. This is not dependent on whether or not warnings are configured to be suppressed.

Table 18 C-STORE Status Codes

Service Status	Further Meaning	Status Code Values	Notes
Refused	Out of Resources	A7xx	
	- Failed to Save to Database	A700	
	- Patient locked	A701	See Table 5
	- Feature not licensed	A702	See Table 14
Error	Data Set does not match SOP Class	A9xx	
	- Invalid Dicom message	A901	See Section A.1
	- Invalid Beam Sequence	A902	See Table 14
	- Invalid Dose Reference Sequence	A903	See Table 10
	- Invalid Tolerance Table Sequence	A904	See Table 11
	- Invalid Patient Setup Sequence	A905	See Table 12
	- Invalid Fraction Group Sequence	A906	See Table 13
Error	Cannot Understand	Cxxx	
	- Missing Patient Identification data	C001	See Note I
	- Inconsistent Patient data	C002	See ???
	- Missing Treatment Machine Name	C003	See Table 14
	- Unrecognised Linac	C004	See Table 14
	- Invalid Linac Energy or Radiation Type	C005	See Table 14
	- Invalid Beam Limiting Device	C006	See Table 14
	- Incomplete Beam Limiting Device combination	C007	See Table 14
	- Unrecognised Block Tray ID	C008	See Note XII
	- Inconsistent Block Tray ID	C009	See Note XII
	- Unsupported Dosimeter Unit	C00A	See Table 14
	- Unsupported Wedge	C00B	See Table 14
	- Under-specified Wedge Position Sequence	C00C	See Table 14
	- Applicator specified with X-rays	C00D	See Table 14
	- Unsupported Applicator	C00E	See Note XIII
	- MLC shape specified with Electrons	C00F	See Table 14
	- Geometric parameter out of customised range	C010	See Table 14
	- Unsupported machine movements	C011	See Table 14
	- Beam too complex	C012	See Table 14
	- Missing Cumulative Meterset Weight	C013	See Table 14
	- Segment Meterset too small	C014	See Note X
	- Plan contains Brachy data	C015	See Table 13
	- Unsupported Treatment Delivery Type	C016	See Table 14
	- Unsupported Fraction Dosimetry	C017	See Table 13
	- Inconsistent Tolerance Table data	C018	See Table 11
	- Invalid MLC Shape or Leaf Positions	C019	See Table 14
	- Under-specified Energy changes	C01A	See Table 14
	- A Dicom storage request specified an untreatable dynamic field	C01B	
Warning	Coercion of Data Elements	B000	
Warning	Data Set does not match SOP Class	B007	
Warning	Elements Discarded	B006	
	- Compensator data ignored		See Note XI
	- Bolus data ignored		See Note XI
	- Block data ignored		See Note XII
	- Tolerance Table data ignored		See Note IV
	- Attribute ignored – Disabled by Configuration		See Appendix C

	- Parameter movements inconsistent with Beam Type		
Success		0000	

APPENDIX C Configurable AE-Specific Attribute Mapping to Integrity™ Database

Certain attributes in the Dicom RT Plan IOD do not map exactly to Integrity™ database parameters, but where integrity constraints are satisfied, a useful default mapping can be defined. These constraints and mappings are identified in Appendix A.

In some situations, it may not be possible for an integrity constraint to be met, or a defined default mapping may be considered inappropriate in a particular clinical environment. To maximise interoperability with a range of Dicom implementations, Integrity™ has an Attribute Mask which can be configured to explicitly **disable** the mapping of certain attributes from an applied RT Plan IOD into the Integrity™ database **on a per-Application Entity basis**.

Table 19 below lists the Dicom attributes that may be masked from mapping. Masking an attribute will override the constraints and mappings defined in Appendix A, and cause the corresponding Integrity™ database parameters to be left UNPRESCRIBED. It will then be necessary for the operator of Integrity™ to specify a valid value for the parameter before the prescription becomes valid for treatment.

A C-STORE response status of WARNING – ELEMENTS DISCARDED will be returned by Integrity™ when data in a C-STORE request is ignored due to configuration.

Table 19 Configurable Attribute Mappings per AE

Flag	Attributes Affected	Notes
Mask Mapping of Tolerance Tables	Tolerance Table Sequence (300A, 0040) and Referenced Tolerance Table (300C, 00A0)	See Note IV. If set, no Tolerance Tables will be imported into Integrity™ and Prescribed Fields will have UNPRESCRIBED but MANDATORY Tolerance Tables.
Mask Mapping of Shadow Tray ID	Block Sequence (300A, 00F4) and Block Tray ID (300A, 00F5) for XRays	See Note XII. If set, Integrity™ Shadow Tray ID will be left UNPRESCRIBED but MANDATORY if Block Sequence is present in applied IOD when creating Xray Fields.
Mask Mapping of Accessory Fitment	Applicator Sequence (300A, 0107) and Applicator ID (300A, 0108), for Electrons	See Note XIII If set, Integrity™ Accessory Fitment will be left UNPRESCRIBED but MANDATORY when creating Electron Fields.
Mask Mapping of Accessory Mount	Applicator Sequence (300A, 0107) and Applicator Type (300A, 0109) for Electrons	See Note XIII. If set, Integrity™ Accessory Mount will be left UNPRESCRIBED but MANDATORY when creating Electron Fields.
Mask Mapping of Energy	Nominal Beam Energy (300A, 0114) Treatment Machine Name (300A, 00B2) and Radiation Type (300A, 00C6)	See Table 14. If set, Integrity™ Energy will be left UNPRESCRIBED but MANDATORY when creating Prescribed Fields.