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Digital Imaging and Communications in Medicine (DICOM)

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Supplement 212: XA Protocol Storage

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VERSION: Draft 15, 2019/01/28

28 Developed pursuant to DICOM Work Item 2018-09-A XA_ModalityProtocolStorage

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DOCUMENT HISTORY

Document Version	Date	Content
Draft 05	March 19, 2017	Initial Outline, starting from Sup121 Final Text. The following has been removed from Sup121 because applicable to all modalities: <ul style="list-style-type: none"> - Defined Procedure Protocol Query/Retrieve Service Classes
Draft 07	April 01, 2017	Minor updates in preparation to WG-02 meeting in May
Draft 09	October 13, 2017	Clean up during WG-02 meeting in October
Draft 10	February 20, 2018	
Draft 14	January 09, 2019	First Reading WG-06
Draft 15	January 28, 2019	Updated after First Reading WG-06 in January 2019

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Text highlighted in yellow are issues/items in need of review/resolution/attention by editor and reviewers.

48 **Text highlighted in grey** are just reminders for the editor about editing work that needs to be done.

Text in blue are changes w.r.t. Sup 121 (to make it XA specific).

50 **Text in red** are text of Sup121 and of PS3.3 that needs to be removed/modified

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Scope and Field of Application

This Supplement defines a pair of storage SOP Classes to distribute defined XA protocols and to record performed XA protocols. Similar pairs of SOP Classes were already added for CT in Supplement 121.

The two storage SOP Classes are:

- **XA Defined Procedure Protocol Storage** SOP Class that describes desired values (and/or value ranges) for various parameters of **procedure, which includes acquisition, reconstruction and storage tasks**. Defined Protocols are independent of a specific patient. Defined Protocols are typically specific to a certain **acquisition equipment** model and/or version (identified by device attributes in the protocol), but model-non-specific protocols are not prohibited.
- **XA Performed Procedure Protocol Storage** SOP Class that describes the values actually used in a performed acquisition. Performed protocols are patient-specific.

The SOP Classes address details including:

- patient preparation & positioning
- equipment characteristics
- acquisition technique
- reconstruction technique
- preliminary image handling such as filtering, enhancement
- results data storage (auto-sending)

The primary goal is to set up the **acquisition equipment**, not to script the entire behavior of the department, or the **angiographic** suite. The protocol object supports simple textual instructions relevant to the protocol such as premedication, patient instructions, etc. Formal coding and management of instructions may be handled with other objects and services such as the Contrast Injection SR or the Modality Worklist (MWL).

It is also not the intent to serialize the internal state of the system. The Defined Procedure Protocol represents a starting point for setting up an **X-Ray Angiographic procedure** for a given patient and the Performed Procedure Protocol represents the actual parameters when the initial **procedure** is completed, but there is no record of the intermediate states between those. New objects describing delayed reconstructions or delayed storage may be added to a study.

The supplement also introduces a Private Data Element dictionary to permit description of **acquisition equipment** model characteristics and the ongoing addition of system-specific features and settings. This dictionary allows protocol management systems to display the value with an appropriate label to the operator.

Methods of specification of tube current modulation (and other technical features) vary between vendors and models and is not addressed in standard DICOM data elements. Vendor protocols are expected to include the relevant private tags and annotate them in the private tag dictionary.

It is expected that the vast majority of protocol objects will be specific to a certain model and version of **acquisition equipment**. There is no requirement that an **equipment** be able to run a protocol from another **equipment**.

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OPEN ISSUES

01	<p>Q: Should it be a supplement for XA/XRF Protocols? Or only XA? A: For the time being, WG-02 assumes only XA</p>
02	<p>Q: The Defined and Performed Storage modules among others contain attributes which description is too much CT specific. There are also attribute conditions related to the CT Protocols SOP Class UID, that should be extended to XA Protocols UIDs.</p>

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CLOSED ISSUES

Scope	

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Changes to NEMA Standards Publication PS 3.2

Digital Imaging and Communications in Medicine (DICOM)

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Part 2: Conformance

Add new SOP Classes in Table A.1-2

106 The SOP Classes are categorized as follows:

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Table A.1-2. UID Values

UID Value	UID Name	Category
...		
<u>1.2.840.10008.5.1.4.1.1.200.X1</u>	<u>XA Defined Procedure Protocol Storage SOP Class</u>	<u>Transfer</u>
<u>1.2.840.10008.5.1.4.1.1.200.X2</u>	<u>XA Performed Procedure Protocol Storage SOP Class</u>	<u>Transfer</u>
...		

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Changes to NEMA Standards Publication PS 3.3

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Part 3: Information Object Definitions

Add to Section 2.6 the following reference:

[NEMA XR-27] National Electrical Manufacturers Association. 2013. X-ray Equipment for Interventional Procedures User Quality Control Mode.

Modify Section 3.8 as shown:

122 ...

124	Acquisition Protocol Element	A sequential component of an the acquisition portion of a protocol, that contains the SCANNING PARAMETERS parameters necessary to perform a single SCAN acquisition . In the case of CT this would correspond to tube voltage, tube current, rotation time, spatial location, etc. and an Acquisition Protocol Element also corresponds to an XR-25 PROTOCOL ELEMENT. <u>In the case of XA this would correspond to technical factors and control algorithms designed to perform the image acquisition, e.g. kVp, mA, pulse width, Dose Related Parameters, IQ targets, rotation range, etc.</u>
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...

132	Protocol Element	A sequential component of a protocol, consisting of all the parameters necessary to perform that component of the protocol.
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134 ...

136	Reconstruction Protocol Element	A sequential component of a the reconstruction portion of a protocol. <u>In the case of CT this would correspond to, such as</u> generating CT thin images or multiplanar reformats. <u>In the case of XA this would correspond to the processing parameters applied before the creation of the X-Ray 2D images (such as binning, bad pixel correction, dynamic range optimization, DSA masking, DSA LUTs, windowing, spatial filters, etc.) and the reconstruction and processing parameters before the creation of the X-Ray 3D volume (such as volume size, slice thickness, artifact removal algorithms, spatial filtering, MIP, Volume Rendering, etc.).</u>
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144 ...

146	Storage Protocol Element	A sequential component of a the storage portion of a protocol, such as sending a series of images to a PACS or an archive or a processing workstation.
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...

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Add new IODs in Table A.1-9

IODs Modules	<u>XA Performed Procedure Protocol</u>	<u>XA Defined Procedure Protocol</u>
Patient	<u>M</u>	
Clinical Trial Subject	<u>U</u>	
General Study	<u>M</u>	
Patient Study	<u>U</u>	
Clinical Trial Study	<u>U</u>	
General Series	<u>M</u>	
Clinical Trial Series	<u>U</u>	
Enhanced Series	<u>M</u>	
<u>XA Protocol Series</u>	<u>M</u>	
Frame of Reference	<u>M</u>	
General Equipment	<u>M</u>	<u>M</u>
Enhanced General Equipment	<u>M</u>	<u>M</u>
Protocol Context	<u>M</u>	<u>M</u>
Patient Protocol Context	<u>U</u>	
Clinical Trial Context		<u>U</u>
Patient Specification		<u>U</u>
Equipment Specification		<u>M</u>
Instructions	<u>U</u>	<u>U</u>
Patient Positioning	<u>U</u>	<u>U</u>
Defined CT Acquisition		
Performed CT Acquisition		
Defined CT Reconstruction		
Performed CT Reconstruction		
<u>Defined XA Acquisition</u>		<u>U</u>
<u>Performed XA Acquisition</u>	<u>U</u>	
<u>Defined XA Reconstruction</u>		<u>U</u>

Performed XA Reconstruction	<u>U</u>	
Defined Storage		<u>U</u>
Performed Storage	<u>U</u>	
Protocol Approval		
SOP Common	<u>M</u>	<u>M</u>

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154 **Modify section A.82 as shown:**

A.82 Procedure Protocol Information Object Definitions

156 Procedure Protocol Information Object Definitions (IODs) encode the details of procedure protocols.

158 Separate IODs are defined for different types of Procedure Protocol, such as an **an CT**-image acquisition Procedure Protocol. A **CT**-Performed Procedure Protocol IOD encodes the details of a procedure that has been performed, and a **CT**-Defined Procedure Protocol IOD specifies details of a procedure that may be used for one or more Procedure Protocols to be performed in the future.

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Add sections to Annex A.82

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A.82.Y1 XA Performed Procedure Protocol IOD

166 A.82.Y1.1 XA Performed Procedure Protocol IOD Description

168 The XA Performed Procedure Protocol IOD describes acquisition, reconstruction, and storage protocol parameter values used during a specific performed XA procedure.

A.82.Y1.2 XA Performed Procedure Protocol IOD Entity-Relationship Model

170 This IOD uses the E-R Model in Section A.1.2, with only the Procedure Protocol IE below the Series IE.

A.82.Y1.3 XA Performed Procedure Protocol IOD Module Table

172 **Table A.82.Y1.3-1. Table XA Performed Procedure Protocol IOD Modules**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced Series	C.7.3.3	M
	XA Protocol Series	C.34.X1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Procedure Protocol	Protocol Context	C.34.2	M
	Patient Protocol Context	C.34.3	U
	Instructions	C.34.7	U
	Patient Positioning	C.34.8	U
	Performed XA Acquisition	C.34.X3	U
	Performed XA Reconstruction	C.34.X5	U
	Performed Storage	C.34.14	U
	SOP Common	C.12.1	M

174 **A.82.Y2 XA Defined Procedure Protocol IOD**

A.82.Y2.1 XA Defined Procedure Protocol IOD Description

176 The XA Defined Procedure Protocol IOD describes acquisition protocol parameters and related details for a defined XA procedure.

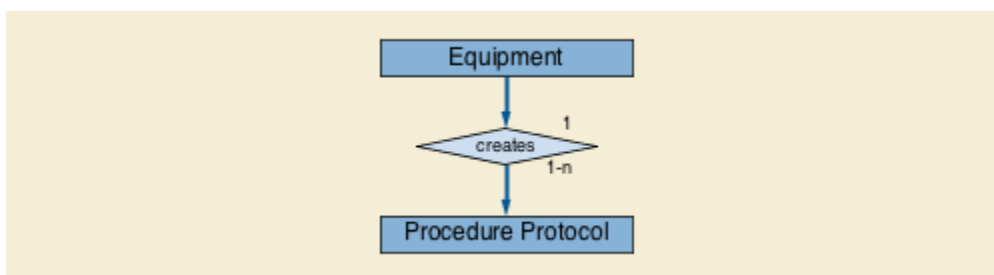
178 See Annex XXXX1 "XA Protocol Storage Examples and Concepts (informative)" in PS3.17 for explanatory information and examples.

180 **A.82.Y2.2 XA Defined Procedure Protocol IOD Entity-Relationship Model**

182 The Procedure Protocol in an XA Defined Procedure Protocol IOD is not associated with a specific patient, however it is associated with the equipment that created the instance.

The E-R model for the XA Defined Procedure Protocol IOD is shown in Figure A.82.Y2.2-1.

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186 **Figure A.82.Y2.2-1. XA Defined Procedure Protocol IOD E-R Model**

A.82.Y2.3 XA Defined Procedure Protocol IOD Module Table

188 **Table A.82.Y2.3-1. XA Defined Procedure Protocol IOD Modules**

IE	Module	Reference	Usage
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Procedure Protocol	Protocol Context	C.34.2	M
	Clinical Trial Context	C.34.4	U
	Patient Specification	C.34.5	U
	Equipment Specification	C.34.6	M
	Instructions	C.34.7	U
	Patient Positioning	C.34.8	U
	Defined XA Acquisition	C.34.X2	U
	Defined XA Reconstruction	C.34.X4	U
	Defined Storage	C.34.13	U
	SOP Common	C.12.1	M

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A.82.Y2.3.1 XA Defined Procedure Protocol IOD Content Constraints

192 **A.82.Y2.3.1.1 Equipment Modality Attribute**

The value of Equipment Modality (0008,0221) shall be XA.

194 Note

An application can query for Protocols by matching on the modality-specific Defined Protocol SOP Class.

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224 **Modify C.7.3.1.1.1 to add XAPROTOCOL to the list of Modality Terms**

C.7.3.1.1.1 Modality

226 Defined Terms:

...

228 **XAPROTOCOL** **XA Protocol (Performed)**

...

230 **Add XA Protocol Modules to Section C.34**

C.34 Procedure Protocol Modules

232 This section describes modules specific to the family of Defined and Performed Procedure Protocol IODs.

...

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C.34.7 Instructions Module

236 Table C.34.7-1 contains instructions relating to preparation and performance of the Protocol.

Table C.34.7-1. Instructions Module Attributes

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Attribute Name	Tag	Type	Attribute Description
Instruction Sequence	(0018,9914)	1	Instructions relating to preparation and performance of the Protocol. See Section C.34.7.1. One or more Items shall be included in this Sequence.
>Instruction Index	(0018,9915)	1	Identifies the order in which instruction sequence items are performed. The value shall be an integer, increasing monotonically by 1, starting from 1.
>Instruction Text	(0018,9916)	1	A short displayable string indicating what should be done.
>Instruction Description	(0018,9917)	3	A detailed description explaining what should be done.
>Instruction Performed Flag	(0018,9918)	2C	Whether or not this instruction was followed in the performed Protocol. Required if the value of SOP Class UID (0008,0016) equals one of the following values: <ul style="list-style-type: none"> • 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage) • <u>1.2.840.10008.5.1.4.1.1.200.X2 (XA Performed Procedure Protocol Storage)</u> Enumerated Values: YES

Attribute Name	Tag	Type	Attribute Description
			NO
>Instruction Performed DateTime	(0018,9919)	2C	Date and time the instruction was performed. Required if Instruction Performed Flag (0018,9918) is present with a value of YES.
>Instruction Performance Comment	(0018,991A)	3	Comment about how the instruction was actually performed, about the outcome of performing the instruction or about why the instruction was not performed.

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240 C.34.8 Patient Positioning Module

Table C.34.8-1 contains details about the positioning of the patient before and during the imaging procedure.

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Table C.34.8-1. Patient Positioning Module Attributes

Attribute Name	Tag	Type	Attribute Description
Protocol Defined Patient Position	(0018,9947)	1	Patient position relative to the equipment described by the procedure protocol. See Section C.7.3.1.1.2 for Defined Terms and further explanation.
Patient Positioning Instruction Sequence	(0018,991B)	3	Instructions for positioning and aligning the patient for the procedure. E.g., aligning an anatomical landmark with laser crosshairs. One or more Items are permitted in this Sequence. The precise correlation between positioning and scan elements is to be described in the Instruction Text if necessary.
>Instruction Index	(0018,9915)	1	Identifies the order in which instruction sequence items are presented/performed. The value shall be an integer, increasing monotonically by 1, starting from 1.
>Instruction Text	(0018,9916)	1	A displayable string explaining what should be done.
>Instruction Description	(0018,9917)	3	A detailed description explaining what should be done.
>Instruction Performed Flag	(0018,9918)	1C	Whether or not this instruction was performed. Required if the value of SOP Class UID (0008,0016) equals <u>one of the following values:</u> <ul style="list-style-type: none"> 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage)

Attribute Name	Tag	Type	Attribute Description
			<ul style="list-style-type: none"> <u>1.2.840.10008.5.1.4.1.1.200.X2 (XA Performed Procedure Protocol Storage)</u> Enumerated Values: YES NO
>Instruction Performed Datetime	(0018,9919)	1C	Date and time the instruction was performed. Required if Instruction Performed Flag (0018,9918) is present with a value of YES.
Positioning Method Code Sequence	(0018,991C)	3	Identifies the method for positioning the patient. Only a single Item shall be included in this Sequence. See Section C.34.8.1.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		Baseline CID 1015 "Patient Alignment Methods".	
Positioning Landmark Sequence	(0018,991D)	3	A coded location identifying the intended landmark used as the basis for positioning. Only a single Item is permitted in this Sequence. See Section C.34.8.1.
>Include Table 10.27-1 "Reference Location Macro Attributes"		Baseline CID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902) Baseline CID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903) Need another CID for XA?	
Target Frame of Reference UID	(0018,991E)	3	UID of the Frame of Reference of another dataset to which the current procedure is intended to be roughly aligned. Note <ol style="list-style-type: none"> For example, in a performed protocol it may be useful to record the Frame of Reference UID used in a prior study that was used as a reference. The Frame of Reference UID (0020,0052) in the image instances resulting from the performance of this protocol will likely be different than this Target Frame of Reference UID since perfect alignment is likely unachievable.
Target Position Reference Indicator	(0020,103F)	3	Position Reference Indicator for the Target Frame of Reference UID (0018,991E). See Section C.34.8.1.

Attribute Name	Tag	Type	Attribute Description
Anatomic Region Sequence	(0008,2218)	2	Identifies the general anatomic region imaged by the Protocol. See Section C.34.8.2. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		Baseline CID 4031 "Common Anatomic Regions".	
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest of this Instance. See Section C.34.8.2. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		Defined CID is CID 2.	
Primary Anatomic Structure Sequence	(0008,2228)	2	Identifies the primary anatomic structure(s) of interest in this Protocol. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of Items that modifies the primary anatomic structure of interest in this Instance. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		Defined CID is CID 2.	

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C.34.X1 XA Protocol Series Module

246 The XA Protocol IODs use the General Series module described in Section C.7.3.1, specialized by the XA Protocol Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of a Protocol.

Table C.34.X1-1 specifies the Attributes that describe a XA Protocol Series.

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Table C.34.X1-1. XA Protocol Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of data in this Series. Enumerated Values: XAPROTOCOL See Section C.7.3.1.1.1 for further explanation.

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C.34.X2 Defined XA Acquisition Module

256 Table C.34.X2-1 contains a specification of acceptable values and ranges of acquisition parameters for an imaging procedure.

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Table C.34.X2-1. Defined XA Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Protocol Element Specification Sequence	(0018,991F)	1	<p>Specification of the acquisition parameters for acquisition protocol elements in an imaging procedure.</p> <p>There shall be one item in this sequence for each Acquisition Protocol Element in the Protocol. See Section C.34.X2.1.</p> <p>One or more Items shall be included in this Sequence.</p>
>Protocol Element Number	(0018,9921)	1	The Protocol Element Number of the Acquisition Protocol Element being specified in this item.
>Parameters Specification Sequence	(0018,9913)	3	<p>Constraints on one or more acquisition parameters.</p> <p>One or more Items are permitted in this Sequence.</p>
>>Include Table 10.25-1 "Attribute Value Constraint Macro Attributes"			<p>Only Attributes defined in Table C.34.X3-1 (i.e., in the Acquisition Protocol Element Sequence (0018,9920) in the Performed XA Acquisition Module) and private Data Elements associated with this acquisition protocol element may be specified as Selector Attributes.</p> <p>The semantics of values of Constraint Violation Significance (0082,0036) in the macro are assigned in C.34.X2.3.</p> <p>The same Attribute shall not appear in more than one item in the sequence with the same values for Selector Sequence Pointer (0072,0052) and Selector Sequence Pointer Items (0074,1057).</p>
>>Modifiable Constraint Flag	(0082,0038)	1C	<p>Specifies whether this constraint may be encoded in a derived instance with a different value. See Section C.34.X2.4.</p> <p>Enumerated Values: YES The constraint may be modified. NO The constraint may not be modified.</p> <p>Required if the constraint may not be modified, may be present otherwise.</p>

260 Note

262 The Performed XA Acquisition Module in the XA Performed Procedure Protocol will generally be "fully
 264 populated". The Defined XA Acquisition Module in the XA Defined Procedure Protocol Object may be
 "sparsely populated" (i.e., contains only the Attributes the system that is specifying the protocol "cares
 about").

Attributes that might commonly be specified here include: **Note: need to reduce this list to 6 or 8**

- 266 • Type of Radiation (0018,1155)
- Scan Options (0018,0022)
- 268 • Acquisition Sub Mode (0028,1090)
- Fluoro Store Number Of Frames (0028,0008)
- 270 • Field of View Dimension(s) (0018,1149)
- Plane Identification (0018,9457)
- 272 • Acquisition Segment Duration (0018,9073)
- Acquisition Segment Frame Rate (0018,0040)
- 274 • KVP (0018,0060)
- X-Ray Tube Current in mA (0018,9330)
- 276 • Exposure in mAs (0018,9332)
- Average Pulse Width (0018,1154)
- 278 • FocalSpot (0018,1190)
- Filter Thickness Minimum (0018,7052)
- 280 • Filter Thickness Maximum (0018,7054)
- Filter Type (0018,1160)
- 282 • Primary Angle Rotation Range (0018,9508)
- Secondary Angle Rotation Range (0018,9509)
- 284 • Primary Angle Rotation Step (0018,9514)
- Secondary Angle Rotation Step (0018,9515)
- 286 • SID (distance source to detector) (0018,1110)
- AutoInjection Contrast Media (0018,9425)

288

C.34.X2.1 Acquisition Protocol Elements

290 An XA Protocol usually includes more than one Acquisition Protocol Element. For example, **a chest Protocol might
 include three elements in total: two localizer CT radiographs (AP and Lateral), and a single helical scan.**

292 Since all parameters will be nested inside an Acquisition Protocol Element Sequence (0018,9920) and some of the
 parameters will be further nested inside a **XA X-Ray Details Sequence (0018,9325)**, close attention must be paid to

294 the use of the Selector Sequence Pointer (0072,0052) in the Attribute Value Constraint Macro. Illustrative examples are provided in Table C.34.X2-2.

296 **Table C.34.X2-2. Example Usage of Selector Macro Attributes for Acquisition Constraints**

Example	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Example Constraint
Constrain the value of Element Name (0018,9922) of the first item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,9922)	1	(0018,9920)	1	EQUAL"Localizer (AP) "
Constrain the value of Table Speed (0018,9309) of the second item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,9309)	1	(0018,9920)	2	EQUAL14 mm/sec
Constrain the value of KVP (0018,0060) of the first beam in the CT X-Ray Details Sequence (0018,9325) of the second item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,0060)	1	(0018,9920), (0018,9325)	2/1	RANGE_INCL(120,140)
Constrain the first and second value of Exposure Modulation Type (0018,9323) of the second beam in the CT X-Ray Details Sequence (0018,9325) of the third item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,9323)	1	(0018,9920), (0018,9325)	3/2	EQUAL"ANGULAR"
	(0018,9323)	2	(0018,9920), (0018,9325)	3/2	EQUAL"ORGAN_BASED"

298 **C.34.X2.2 Dose Related Attributes in Parameter Specification Sequence**

[Do we need content here for XA? E.g. High Dose rate alarm, Fluoro time alarm...]

300

C.34.X2.3 Attribute Value Constraint Macro

302 The XA Defined Procedure Protocol SOP Class assigns the following significance to the values of Constraint Violation Significance (0082,0036) :

- 304 • FAILURE - Violating the constraint is a violation of the Protocol and requires supervisory permission and auditing.
- WARNING - Violating the constraint is a violation of the Protocol and requires operator confirmation and auditing.
- 306 • INFORMATIVE - Violating the constraint is not a violation of the Protocol. The constraint represents a guideline. Violation of the guideline may be recorded or shown to the operator.

308 If the attribute is absent, a value of INFORMATIVE may be assumed.

C.34.X2.4 Modifiable Constraint Flag

310 New protocol instances derived from original protocol instances with different constraints on a given attribute "modify" the constraint. This flag may be used by devices that create original instances to specify which constraints can be modified by other devices in derived instances.

314 For example, an XA device that creates a Defined Procedure Protocol, may indicate that the Element Name (0018,9922) of the Acquisition Protocol Element may be modified, but the Focal Spot (0018,1190) constraint may not since the latter depends on correlated changes by the device to other attributes. Such information would be useful to a protocol management workstation that is letting its operator make changes to the Focal Spot.

Note

318 There is a difference between these "derivation" modifications and what an operator does at the time of protocol execution. At execution time, the operator is using the XA device to change Selector Attribute values and those values are compared to the Constraint Values in the Constraint Macro of the Defined Protocol. The result may (or may not be) stored in a Performed Procedure Protocol instance. At derivation time, an operator is using a workstation to change Constraint Values in the Constraint Macro and store a new Defined Procedure Protocol Instance.

324

C.34.X3 Performed XA Acquisition Module

326 This Module contains acquisition parameter values for a performed XA imaging procedure. The purpose of this module is to record all relevant parameters, not just to record the values that were constrained in the executed Defined Protocol (if any).

330 This Module contains Attributes that are "set" on the machine, e.g., to affect its behavior, but not those that describe the results. The latter may be found in the reconstructed images.

Table C.34.X3-1. Performed XA Acquisition Module Attributes

332

This table is Work In Progress, needs to replace CT parameters by XA parameters

334

Acquisition Protocol Element Sequence	(0018,9920)
<i>>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"</i>	
> Protocol Element Number	(0018,9921)
338 > Protocol Element Name	(0018,9922)
> Protocol Element Purpose	(0018,9924)
340 > Protocol Element Characteristics Summary	(0018,9923)

Note: include here the parameters that appear only once in the protocol element (same for both planes)

- 342 > Type of Radiation (0018,1155)
- > Scan Options (0018,0022)
- 344 > Fluoro Store Number Of Frames (0028,0008)
- > Single plane or biplane acquisition (xxxx,xxxx)
- 346 > AutoInjection Contrast Media (0018,9425)
- > Contrast Administration Profile Sequence (0018,9340)
- >> Auto Injection Enabled (xxxx,xxxx)
- >> Contrast/Bolus injection delay vs. X-Ray (xxxx,xxxx)
- 350 >> Contrast Flow Rate (0018,1046)
- >> Contrast Flow Duration (0018,1047)
- 352 >> Contrast/Bolus Ingredient (0018,1048)
- > XA Plane Details Sequence (xxxx,xxxx)
- >> Plane Identification (0018,9457) // PLANE A or PLANE B or SINGLE PLANE
- >> Acquisition Sub Mode (0028,1090)
- 356 >> Field of View Dimension(s) (0018,1149)
- >> KVP (0018,0060)
- 358 >> X-Ray Tube Current in mA (0018,9330)
- >> Exposure in mAs (0018,9332)
- 360 >> Average Pulse Width (0018,1154)
- >> FocalSpot (0018,1190)
- 362 >> Filter Thickness Minimum (0018,7052)
- >> Filter Thickness Maximum (0018,7054)
- 364 >> Filter Type (0018,1160)
- >> Rotational Primary Angle Rotation Range (0018,9508)
- 366 >> Rotational Secondary Angle Rotation Range (0018,9509)
- >> Rotational Primary Angle Rotation Step (0018,9514)
- 368 >> Rotational Secondary Angle Rotation Step (0018,9515)
- >> Rotational SID (distance source to detector) (0018,1110)
- 370 >>> DSA Segment Details Sequence (xxxx,xxxx)
- >>> Acquisition Segment Duration (0018,9073)
- 372 >>> Acquisition Segment Frame Rate (0018,0040)

374

376

Attribute Name	Tag	Type	Attribute Description
Acquisition Protocol Element Sequence	(0018,9920)	2	Parameter values for each Protocol Element in the acquisition protocol. Each item in the sequence describes one Element. Elements are performed in the order of their Protocol Element Number (0018,9921). See Section C.34.9.1. Zero or more Items shall be included in this Sequence.
>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"			
>Acquisition Type	(0018,9302)	1	Description of the method used during acquisition.

Attribute Name	Tag	Type	Attribute Description
			See Section C.8.15.3.2.1 for Defined Terms.
>Tube Angle	(0018,9303)	1C	<p>The constant angle at which the x-ray source is located during acquisition. 0 degrees means that the source is located at the highest point of the gantry orbit. Degrees increase from 0 to positive 360 in a clockwise direction as viewed when facing the gantry where the table enters the gantry.</p> <p>Required if Acquisition Type (0018,9302) is CONSTANT_ANGLE.</p>
>Constant Volume Flag	(0018,9333)	1	<p>Identifies that the acquisition was performed by repetitively acquiring the same volume set over a period of time.</p> <p>Note</p> <p>The Acquisition Type (0018,9302) value may be SEQUENCED, SPIRAL or STATIONARY depending on whether table movement is necessary to cover the volume.</p> <p>Enumerated Values:</p> <p>YES NO</p>
>Fluoroscopy Flag	(0018,9334)	1	<p>Identifies that near real-time display of a block of continuously acquired data was performed.</p> <p>Enumerated Values:</p> <p>YES NO</p>
>Revolution Time	(0018,9305)	1C	<p>The time in seconds of a complete revolution of the source around the gantry orbit. This value is independent of the Reconstruction Angle (0018,9319) of the frame.</p> <p>Required if Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.</p>
>Single Collimation Width	(0018,9306)	1	<p>The width of a single row of acquired data (in mm).</p> <p>Note</p> <p>Adjacent physical detector rows may have been combined to form a single effective acquisition row.</p>
>Total Collimation Width	(0018,9307)	1	<p>The width of the total collimation (in mm) over the area of active x-ray detection.</p> <p>Note</p>

Attribute Name	Tag	Type	Attribute Description
			This will be equal to the number of effective detector rows multiplied by single collimation width.
>Table Height	(0018,1130)	1	The distance in mm from the top of the patient table to the center of rotation of the source (i.e., the data collection center or isocenter). The distance is positive when the table is below the data collection center.
>Gantry/Detector Tilt	(0018,1120)	1	Nominal angle of tilt in degrees of the scanning gantry. Not intended for mathematical computations. Zero degrees means the gantry is not tilted, negative degrees are when the top of the gantry is tilted away from where the table enters the gantry.
>Table Speed	(0018,9309)	1	The distance in mm that the table moves in one second during the gathering of data.
>Table Feed per Rotation	(0018,9310)	1	Motion of the table (in mm) during a complete revolution of the source around the gantry orbit.
>Spiral Pitch Factor	(0018,9311)	1	Ratio of the Table Feed per Rotation (0018,9310) to the Total Collimation Width (0018,9307).
>CTDIvol	(0018,9345)	1C	Computed Tomography Dose Index (CTDI _{vol}), in mGy according to IEC 60601-2-44, Ed.2.1 (Clause 29.1.103.4), The Volume CTDI _{vol} . It describes the average CTDIvol for this AcquisitionProtocol Element for the selected CT conditions of operation. Required if Acquisition Type (0018,9302) is not CONSTANT_ANGLE. May be present otherwise.
>CTDI Phantom Type Code Sequence	(0018,9346)	1C	The type of phantom used for CTDI measurement according to IEC 60601-2-44. Required if CTDIvol (0018,9345) is present. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		Defined CID 4052 "Phantom Devices".	
>CTDIvol Notification Trigger	(0018,9942)	3	The threshold for the CTDIvol value, in mGy, at which a dose notification is triggered for this Acquisition Protocol Element. See Section C.34.10.2.
>DLP Notification Trigger	(0018,9943)	3	The threshold for the DLP value, in mGy.cm, at which a dose notification is triggered for this Acquisition Protocol Element. See Section C.34.10.2.

Attribute Name	Tag	Type	Attribute Description
>Acquisition Motion	(0018,9930)	1	<p>Motion of scan progression.</p> <p>See Section C.34.10.1.</p> <p>Defined Terms:</p> <p>SINGLE Scan progresses in a single pass from Acquisition Start Location to Acquisition End Location.</p> <p>SHUTTLE Scan progresses from Acquisition Start Location to Acquisition End Location, then reverses direction and scans back to Acquisition Start Location.</p> <p>NO_MOTION All slices are acquired simultaneously.</p> <p>NOT_IMPORTANT Acan either direction is acceptable.</p> <p>The value of NOT_IMPORTANT is not permitted in the Performed Procedure Protocol IOD.</p>
>Acquisition Start Location Sequence	(0018,9931)	3	<p>Anatomically oriented transverse location where this acquisition starts.</p> <p>Note</p> <ol style="list-style-type: none"> This represents the nominal start location. Due to overscan, tissue may be irradiated beyond this location. In a Defined Procedure Protocol, this represents the intended start location. The operator may or may not select a location that exactly matches this anatomical location. In a Performed Procedure Protocol, this value may have been copied from the Defined Procedure Protocol and may not represent the exact anatomical location selected by the operator. <p>Only a single item is permitted in the sequence.</p>
>>Include Table 10.27-1 "Reference Location Macro Attributes"			<p>Baseline CID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902)</p> <p>Baseline CID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)</p>
>Acquisition End Location Sequence	(0018,9932)	3	<p>Anatomically oriented transverse location where this acquisition ends.</p> <p>Note</p> <ol style="list-style-type: none"> This represents the nominal end location. Due to overscan, tissue may be irradiated beyond this location. In a Defined Procedure Protocol, this represents the intended end location. The operator may or may not select a location that

Attribute Name	Tag	Type	Attribute Description
			<p>exactly matches this anatomical location.</p> <p>3. In a Performed Procedure Protocol, this value may have been copied from the Defined Procedure Protocol and may not represent the exact anatomical location selected by the operator.</p> <p>Only a single item is permitted in the sequence.</p>
>>Include Table 10.27-1 "Reference Location Macro Attributes"			<p>Baseline CID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902)</p> <p>Baseline CID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)</p>
>CT X-Ray Details Sequence	(0018,9325)	1	<p>Parameter values for each of the X-Ray beams in the Acquisition Protocol Element. Each item in the sequence describes one X-Ray beam.</p> <p>See Section C.34.10.3.</p> <p>One or more Items shall be included in this sequence.</p>
>>Beam Number	(300A,00C0)	1	Identification number of the beam.
>>KVP	(0018,0060)	1	Peak kilo voltage output of the x-ray generator.
>>Exposure Time in ms	(0018,9328)	1	<p>Duration of exposure for this Acquisition Protocol Element in milliseconds.</p> <p>If Acquisition Type (0018,9302) equals SPIRAL the duration of exposure shall be weighted by the Spiral Pitch Factor (0018,9311).</p>
>>X-Ray Tube Current in mA	(0018,9330)	1	Nominal X-ray tube current in milliamperes.
>>Exposure in mAs	(0018,9332)	1	The exposure expressed in milliamperere seconds, for example calculated from exposure time and X-Ray tube current.
>>Auto KVP Selection Type	(0018,9944)	1	<p>The type of automated selection of the kVp value.</p> <p>Defined Terms:</p> <p>NONE Value is not selected automatically.</p> <p>CNR_BASED Value is selected based on Contrast to Noise Ratio.</p> <p>DIAMETER_BASED Value is selected based on patient diameter.</p>
>>Auto KVP Upper Bound	(0018,9945)	3	<p>Upper limit on the value of the auto-selected kVp.</p> <p>Note</p> <p>Constraints on KVP (0018,0060) represent constraints on the nominal KVP for the scan. Auto</p>

Attribute Name	Tag	Type	Attribute Description
			KVP Upper Bound (0018,9945) represents a direct constraint on the range of values that may be produced by the automated selection of the kVp value.
>>Auto KVP Lower Bound	(0018,9946)	3	Lower limit on the value of the auto-selected kVp. Note Constraints on KVP (0018,0060) represent constraints on the nominal KVP for the scan. Auto KVP Lower Bound (0018,9946) represents a direct constraint on the range of values that may be produced by the automated selection of the kVp value.
>>Exposure Modulation Type	(0018,9323)	1	A multivalued label describing the type of current modulation used for the purpose of limiting the dose. Defined Terms: NONE ANGULAR Current is modulated over different tube angles. LONGITUDINAL Current is modulated along the axis of the table. ECG_BASED Current is modulated based on the cardiac phase. ORGAN_BASED Current is modulated based on the organs in the field of view.
>>Focal Spot(s)	(0018,1190)	1	Used nominal size of the focal spot in mm. The Attribute may only have one or two values, for devices with variable focal spot, small dimension followed by large dimension.
>>Data Collection Diameter	(0018,0090)	1	The diameter in mm of the region over which data were collected. See Section C.8.15.3.6.1. Note In the case of an Acquisition Type (0018,9302) of CONSTANT_ANGLE, the diameter is that in a plane normal to the central ray of the diverging X-ray beam as it passes through the data collection center.
>>Filter Type	(0018,1160)	1	Type of filter(s) inserted into the X-Ray beam. Defined Terms: NONE WEDGE BUTTERFLY STRIP MULTIPLE BOWTIE

Attribute Name	Tag	Type	Attribute Description
			Note Multiple filters can be expressed by a combination of terms, e.g., BUTTERFLY+WEDGE....
>>Cardiac Synchronization Technique	(0018,9037)	1	Cardiac synchronization technique applied during acquisition or processing. Enumerated Values: NONE REALTIME PROSPECTIVE RETROSPECTIVE PACED See Section C.7.6.18.1.
>>Cardiac Signal Source	(0018,9085)	1C	Source of cardiac synchronization signal. Defined Terms: ECG Electrocardiogram. VCG Vector cardiogram. PP Peripheral pulse. Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE.
>>Cardiac RR Interval Specified	(0018,9070)	1C	R-R interval in ms measured prior to or during the scan. Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE.
>>Cardiac Beat Rejection Technique	(0018,9169)	1C	Cardiac arrhythmia rejection technique. Defined Terms: NONE RR_INTERVAL Rejection based on deviation from average RR interval. QRS_LOOP Rejection based on deviation from regular QRS loop. PVC Rejection based on PVC criteria. Required if Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.
>>Low R-R Value	(0018,1081)	2C	R-R interval low limit for beat rejection, in ms. Required if Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.
>>High R-R Value	(0018,1082)	2C	R-R interval high limit for beat rejection, in ms. Required if Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.

Attribute Name	Tag	Type	Attribute Description
>>Skip Beats	(0018,1086)	3	Number of beats prescribed to be skipped after each detected arrhythmia.
>>Cardiac Framing Type	(0018,1064)	1C	Type of framing performed. See Section C.7.6.18.1.1.1 for description and Defined Terms. Required if type of framing is not time forward from trigger, may be present otherwise.
>>Respiratory Motion Compensation Technique	(0018,9170)	1	Technique to reduce respiratory motion artifacts. Defined Terms: NONE BREATH_HOLD REALTIME GATING TRACKING RETROSPECTIVE CORRECTION See Section C.7.6.18.2.
>>Respiratory Signal Source	(0018,9171)	1C	Signal source from which respiratory motion is derived. Defined Terms: NONE BELT NASAL_PROBE CO2_SENSOR ECG Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE or BREATH_HOLD. May be present otherwise.
>>Respiratory Trigger Delay Threshold	(0020,9256)	1C	Respiratory trigger threshold in percent of the chest expansion for the frame relative to the last Respiratory-Peak. See Section C.7.6.16.2.17.1 for further explanation. Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE, REALTIME or BREATH_HOLD. May be present otherwise.
>>Respiratory Trigger Type	(0020,9250)	1C	Characteristic of the respiratory signal used to the define the respiratory triggering. Defined Terms: TIME AMPLITUDE

Attribute Name	Tag	Type	Attribute Description
			BOTH Required if the value is not TIME. May be present otherwise.
>Requested Series Description	(0018,9937)	3	Requested text to copy into the Series Description(0008,103E) of raw instances resulting from this Acquisition Protocol Element.
>Content Qualification	(0018,9004)	3	Content Qualification Indicator of instances resulting from this Acquisition Protocol Element. Enumerated Values: PRODUCT RESEARCH SERVICE See Section C.34.12.1.

C.34.X3.1 Acquisition Motion

378 [Do we need content here for XA?]

C.34.X3.2 Dose Notification Triggers

380 [Do we need content here for XA?]

C.34.X3.3 X-Ray Details Sequence

382 Some systems perform Acquisition Protocol Elements with multiple tubes operating simultaneously, or with a tube
384 switching back and forth between two energy settings. Such acquisitions are encoded with multiple items in this sequence.

{NOTE: Add C.34.X3.n for other XA-specific topics, e.g. Biplane acquisitions...}

386 {NOTE: Add C.34.X4 and C.34.X5 for Defined and Performed XA Display Modules}

388 C.34.X4 Defined XA Reconstruction Module

390 Table C.34.X4-1 contains specification of acceptable values and ranges of reconstruction parameters for an imaging procedure.

Table C.34.X4-1. Defined XA Reconstruction Module Attributes

392

Attribute Name	Tag	Type	Attribute Description
Reconstruction Protocol Element	(0018,9933)	1	Specification of the parameters for

Attribute Name	Tag	Type	Attribute Description
Specification Sequence			reconstruction of the acquired data of an imaging procedure. There shall be one item in this sequence for each reconstruction protocol element in the Protocol. See Section C.34.11.1. One or more Items shall be included in this Sequence.
>Protocol Element Number	(0018,9921)	1	The Protocol Element Number of the Reconstruction Protocol Element being specified in this item.
>Parameters Specification Sequence	(0018,9913)	3	Constraints on reconstruction parameters. One or more Items are permitted in this Sequence.
>>Include Table 10.25-1 "Attribute Value Constraint Macro Attributes"			Only Attributes defined in Table C.34.12-1 (i.e., in the Reconstruction Protocol Element Sequence (0018,9934) in the Performed CT Reconstruction Module) and private Data Elements associated with this reconstruction protocol element may be specified as Selector Attributes. The semantics of values of Constraint Violation Significance (0082,0036) in the macro are assigned in C.34.9.3. The same Attribute shall not appear in more than one item in the sequence with the same values for Selector Sequence Pointer (0072,0052) and Selector Sequence Pointer Items (0074,1057).
>>Modifiable Constraint Flag	(0082,0038)	1C	Whether this constraint may be encoded in a derived instance with a different value. See Section C.34.9.4. Required if the constraint may not be modified, may be present otherwise. Enumerated Values: YES The constraint may be modified. NO The constraint may not be modified.

394 Attributes that might commonly be specified here include:

[WG-02: use tags of the X-Ray 3D IOD]

396 - Add settings like:

o Metal artifact reduction enabled (or level),

398 o Noise reduction

• Reconstruction Algorithm (0018,9315)

400 • Convolution Kernel (0018,1210)

• Reconstruction Diameter (0018,1100)

402 • Slice Thickness (0018,0050)

- Pixel Spacing (0028,0030)

404 **C.34.X4.1 Reconstruction Protocol Elements**

406 An XA Protocol may specify multiple reconstructions. For example, a single subtracted rotational Acquisition Protocol Element may be reconstructed once as mask slices and a second time as subtracted slices.

C.34.X5 Performed XA Reconstruction Module

408 This Module contains reconstruction parameter values for a performed XA imaging procedure.

410 This Module contains Attributes that affect machine behavior but not those that are merely descriptive. The latter may be found in the reconstructed images.

Table C.34.X5-1. Performed XA Reconstruction Module Attributes

412

This table is Work In Progress, needs to replace CT parameters by XA parameters

414

Attribute Name	Tag	Type	Attribute Description
Reconstruction Protocol Element Sequence	(0018,9934)	1	Parameter values for each reconstruction protocol element in the Protocol. See Section C.34.11.1. Elements are performed in the order of their Protocol Element Number (0018,9921). One or more Items shall be included in this Sequence.
<i>>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"</i>			
<i>>Source Acquisition Protocol Element Number</i>	(0018,9938)	1	A value corresponding to the Protocol Element Number (0018,9921) of the Acquisition Protocol Element from this Protocol being reconstructed in this reconstruction protocol element. This may be multivalued if multiple acquisitions are combined in a single reconstruction protocol element.
<i>>Source Acquisition Beam Number</i>	(0018,9939)	1	One or more values corresponding to the Beam Number (300A,00C0) in the Acquisition Protocol Element (specified in Source Acquisition Protocol Element Number (0018,9938)) from which data was used in this reconstruction protocol element.
<i>>Referenced SOP Class UID</i>	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if the referenced acquisition protocol element is not in this instance. Shall have a value of 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage).
<i>>Referenced SOP Instance UID</i>	(0008,1155)	1C	The UID of the instance containing the acquisition protocol element referenced in Source Acquisition Protocol

Attribute Name	Tag	Type	Attribute Description
			<p>Element Number (0018,9938).</p> <p>Required if the referenced acquisition protocol element is not in this instance.</p>
>Reconstruction Start Location Sequence	(0018,993B)	1	<p>Anatomically oriented transverse location where this reconstruction starts.</p> <p>Note</p> <ol style="list-style-type: none"> 1. This represents the start of the data used in the reconstruction, not necessarily the slice location of the first reconstructed slice. 2. This represents the intended start location. The operator may or may not have selected a location that exactly matches this anatomical location. 3. In the case where an anatomical reference basis cannot be determined or derived from the Defined Protocol instance, for example when an ad hoc reconstruction is being performed, the implementation may use the acquired volume (128160, DCM, "Acquired Volume") as the reference basis with an appropriate offset. <p>Only a single item is permitted in the sequence.</p>
>>Include Table 10.27-1 "Reference Location Macro Attributes"			<p>Baseline CID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902)</p> <p>Baseline CID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)</p>
>Reconstruction End Location Sequence	(0018,993C)	1	<p>Anatomically oriented transverse location where this reconstruction ends.</p> <p>Note</p> <ol style="list-style-type: none"> 1. This represents the end of the data used in the reconstruction, not necessarily the slice location of the last reconstructed slice. 2. This represents the intended end location. The operator may or may not have selected a location that exactly matches this anatomical location. 3. In the case where an anatomical reference basis cannot be determined or borrowed from the Defined Protocol instance, for example when an ad hoc reconstruction is being performed, the implementation may use the acquired volume (128160, DCM, "Acquired Volume") as the reference basis with an appropriate offset.

Attribute Name	Tag	Type	Attribute Description
			Only a single item is permitted in the sequence.
>>Include Table 10.27-1 "Reference Location Macro Attributes"			Baseline CID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902) Baseline CID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)
>Reconstruction Algorithm Sequence	(0018,993D)	3	Algorithm used in this reconstruction protocol element. Only a single item is permitted in the sequence.
>>Include Table 10-19 "Algorithm Identification Macro Attributes"			Baseline CID 10033 "CT Reconstruction Algorithm" for Algorithm Family Code Sequence (0066,002F)
>Convolution Kernel	(0018,1210)	1	A label describing the convolution kernel or algorithm used to reconstruct the data. A single value shall be present.
>Convolution Kernel Group	(0018,9316)	1	A label describing the group that the Convolution Kernel (0018,1210) belongs to. Defined Terms: BRAIN SOFT_TISSUE LUNG BONE CONSTANT_ANGLE
>Reconstruction Diameter	(0018,1100)	1C	The diameter in mm of the region from which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. See Section C.8.15.3.6.1. Required if Reconstruction Field of View (0018,9317) is not present.
>Reconstruction Field of View	(0018,9317)	1C	The field of view width (x-dimension) followed by height (y-dimension) as used for reconstruction in mm. Required if Reconstruction Diameter (0018,1100) is not present.
>Reconstruction Target Center (Patient)	(0018,9318)	3	The x, y, and z coordinates (in the patient coordinate system) of the reconstruction center target point as used for reconstruction in mm. See Section C.8.15.3.6.1. Note If the reconstructed image is not magnified or panned the value corresponds with the Data Collection Center (0018,9313) Attribute.

Attribute Name	Tag	Type	Attribute Description
>Reconstruction Target Center Location Sequence	(0018,993E)	3	An anatomically based description of a point in the patient used as the reconstruction center target point. Note This represents the intended reconstruction center location. They operator may or may not select a location that exactly matches this anatomical location.
>>Include Table 10.27-1 "Reference Location Macro Attributes"			Baseline CID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902) Baseline CID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)
>Reconstruction Pixel Spacing	(0018,9322)	1	Physical distance in the patient between the center of each reconstructed pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order.
>Rows	(0028,0010)	1	Number of rows in the reconstructed image.
>Columns	(0028,0011)	1	Number of columns in the reconstructed image.
>Reconstruction Angle	(0018,9319)	1	Angle (in degrees) over which the data from which the frame was reconstructed was collected.
>Image Filter	(0018,9320)	3	A label describing the filter applied to the reconstructed image after the original reconstruction has been completed.
>Image Filter Description	(0018,9941)	3	A description of the nature or effect of the Image Filter (0018,9320). E.g., sharpening, noise removing, edge enhancing.
>Derivation Code Sequence	(0008,9215)	3	Additional processing applied to the reconstructed image after image filter (if any)
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			
>Slice Thickness	(0018,0050)	1	Nominal reconstructed slice thickness, in mm.
>Spacing Between Slices	(0018,0088)	1	Spacing between slices, in mm. The spacing is measured from the center-to-center of each slice. Note Slice overlap may be constrained implicitly by constraining the Slice Thickness (0018,0050) and Spacing Between Slices (0018,0088). However, since each constraint is considered independently, the overlap may be any value

Attribute Name	Tag	Type	Attribute Description
			resulting from the combination of allowable values for thickness and spacing.
>Window Center	(0028,1050)	3	Preferred value for Window Center (0028,1050) in the image instances produced by this reconstruction protocol element.
>Window Width	(0028,1051)	3	Preferred value for Window Width (0028,1051) in the image instances produced by this reconstruction protocol element.
>Requested Series Description	(0018,9937)	3	Requested text to copy into the Series Description(0008,103E) of the images resulting from this reconstruction protocol element.
>Content Qualification	(0018,9004)	3	Content Qualification Indicator of instances resulting from this Reconstruction Protocol Element. Enumerated Values: PRODUCT RESEARCH SERVICE See Section C.34.12.1.

416 C.34.X5.1 Content Qualification

418 Content Qualification (0018,9004), if present, specifies the value to be copied into reconstructed instances. For details on the meaning of this attribute in those instances, see section C.8.13.2.1.1.

This attribute does not describe the content qualification of the protocol itself.

420

Modify C.34.13 to include XA in the Attribute Description and in the examples.

422 C.34.13 Defined Storage Module

424 Table C.34.13-1 contains specification of acceptable values and ranges of storage parameters for an imaging procedure. Storage protocol elements may be used to automatically send the output of particular protocol elements to particular destinations. For example, a lung protocol might send thick images to PACS for reading and thin images to a CAD workstation for detection of nodules; a cardiac protocol might send an image set to a clinical analysis workstation; and a protocol used for pre-operative hip replacement planning might send images to the orthopedics department.

428 **Table C.34.13-1. Defined Storage Module Attributes**

Attribute Name	Tag	Type	Attribute Description
Storage Protocol Element Specification Sequence	(0018,9935)	1	Specification of the parameters for storage of imaging data. There shall be one item in this sequence for each Storage Protocol Element. See

Attribute Name	Tag	Type	Attribute Description
			Section C.34.13.1. One or more Items shall be included in this Sequence.
>Protocol Element Number	(0018,9921)	1	The Protocol Element Number of the Storage Protocol Element being specified in this item.
>Parameters Specification Sequence	(0018,9913)	3	Constraints on storage parameters. One or more Items are permitted in this Sequence.
>>Include Table 10.25-1 "Attribute Value Constraint Macro Attributes"			Only Attributes defined in Table C.34.14-1 (i.e., in the Storage Protocol Element Sequence (0018,9936) in the Performed Storage Module) and private Data Elements associated with this storage protocol element may be specified as Selector Attributes. The semantics of values of Constraint Violation Significance (0082,0036) in the macro are assigned in C.34.9.3 (for CT) and in C.34.X2 (for XA) . The same Attribute shall not appear in more than one item in the sequence with the same values for Selector Sequence Pointer (0072,0052) and Selector Sequence Pointer Items (0074,1057).
>>Modifiable Constraint Flag	(0082,0038)	1C	Whether this constraint may be encoded in a derived instance with a different value. See Sections C.34.9.4 and C.34.X2 . Required if the constraint may not be modified, may be present otherwise. Enumerated Values: YES The constraint may be modified. NO The constraint may not be modified.

430 Attributes that might be specified here include:

- Source Reconstruction Protocol Element Number (0018,993A) of reconstructed slices that will be saved
- 432 • Source Acquisition Protocol Element Number (0018,9938) if raw data is to be stored
- Destination AE (2100,0140) where the images will be stored

434 C.34.13.1 Storage Protocol Elements

436 A ~~CT~~–Protocol frequently specifies multiple storage protocol elements. For example, in CT thin slices may be transmitted to a 3D workstation, while raw data is stored on a local cache and thick slices are stored to PACS for reading.

438

Modify C.34.14 to make it generic to all modalities, not specific to CT

440 C.34.14 Performed Storage Module

This Module contains storage parameter values for a performed imaging procedure.

442

Table C.34.14-1. Performed Storage Module Attributes

Attribute Name	Tag	Type	Attribute Description
Storage Protocol Element Sequence	(0018,9936)	1	<p>Parameter values for each storage protocol element in the Protocol. The output instances of the referenced Acquisition or Reconstruction Protocol Elements are stored to the location specified in the Output Information Sequence.</p> <p>See Section C.34.13.1.</p> <p>One or more Items shall be included in this Sequence.</p> <p>The performing system might not support the requested storage protocol or not be configured for the desired destination.</p> <p>Note</p> <p>Whether to report failure of one or more of the storage protocol elements as a failure of the protocol is at the discretion of the performing system. The performing system may, additionally or as a fallback, be configured to store output objects to a default destination or retain them locally.</p>
<i>>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"</i>			
>Source Acquisition Protocol Element Number	(0018,9938)	1C	<p>A value corresponding to the Element Number (0018,9921) of the Acquisition Protocol Element for which data is stored.</p> <p>Note</p> <p>Source Acquisition Protocol Element references are for storage of raw acquisition data. Reconstructed slice storage involves reference to the corresponding Reconstruction Protocol Element in the Source Reconstruction Protocol Element Number (0018,993A).</p> <p>This may be multivalued if multiple acquisition protocol element data are being stored together.</p> <p>Required if Source Reconstruction Protocol Element Number (0018,993A) is not present.</p>
>Source Reconstruction Protocol Element Number	(0018,993A)	1C	<p>The Element Number (0018,9921) corresponding to the Reconstruction Protocol Element for which data is stored.</p> <p>This may be multivalued if multiple reconstruction protocol element data are being stored together.</p> <p>Required if Source Acquisition Protocol Element Number (0018,9938) is not present.</p>
>Source Acquisition Beam Number	(0018,9939)	1C	<p>The Beam Number (300A,00C0) in the Acquisition Protocol Element (specified in Source Acquisition Protocol Element Number (0018,9938)) for which data is stored. Multiple values may be specified if data for multiple beams is being stored.</p>

Attribute Name	Tag	Type	Attribute Description
			<p>Required if SOP Class UID (0008,0016) has a value of 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage) and Source Acquisition Protocol Element Number (0018,9938) is present and only some of the beams in the Acquisition Protocol Element are to be stored.</p> <p>Add XA Performed Procedure Protocol Storage UID (1.2.840.10008.5.1.4.1.1.200.X2)</p>
>Referenced SOP Class UID	(0008,1150)	1C	<p>Uniquely identifies the referenced SOP Class.</p> <p>Required if the referenced acquisition or reconstruction element is not in this instance.</p> <p>Enumerated Values: 1.2.840.10008.5.1.4.1.1.200.2 CT Performed Procedure Protocol Storage 1.2.840.10008.5.1.4.1.1.200.X2 XA Performed Procedure Protocol Storage</p>
>Referenced SOP Instance UID	(0008,1155)	1C	<p>The UID of the Protocol instance containing the element referenced in Source Reconstruction Protocol Element Number (0018,993A) or Source Acquisition Protocol Element Number (0018,9938).</p> <p>Required if the referenced acquisition protocol element is not in this instance.</p>
>Output Information Sequence	(0040,4033)	1	<p>References to acquired and reconstructed data objects stored as part of this storage protocol element.</p> <p>One or more Items shall be included in this Sequence.</p> <p>Note</p> <p>It is expected that the storage destinations for Radiation Dose SR instances and Performed Protocol objects will be managed by direct configuration of the acquisition device rather than using this sequence on a protocol by protocol basis.</p>
>>Include Table 10-3c "Storage Macro Attributes"			

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Changes to NEMA Standards Publication PS 3.4

464

Digital Imaging and Communications in Medicine (DICOM)

Part 4: Service Class Specifications

466

Add SOP Class to Table B.5-1

468 B.5 Standard SOP Classes

470 The SOP Classes in the Storage Service Class identify the Composite IODs to be stored. Table B.5-1 identifies Standard SOP Classes.

472 **Table B.5-1. Standard SOP Classes**

SOP Class Name	SOP Class UID	IOD Specification (defined in PS3.3)
...		
<u>XA Performed Procedure Protocol Storage</u>	<u>1.2.840.10008.5.1.4.1.1.200.X2</u>	<u>XA Performed Procedure Protocol IOD</u>
...		

474

476 **Add new section to B.5.1 to describe SCP requirements for XA Performed Procedure Protocol Storage**

B.5.1.X1 XA Performed Procedure Protocol Storage SOP Class

478 The XA Performed Procedure Protocol Storage SOP Class encodes the acquisition, processing, and reconstruction protocol parameter values used during a specific performed XA procedure and related details.

480 For a device that is both a SCU and a SCP of the XA Performed Procedure Protocol Storage SOP Class, in addition to the behavior for the Storage Service Class specified in Section B.2.2, the following additional requirements are
482 specified for XA Performed Procedure Protocol Storage SOP Classes:

- A SCP of this SOP Class shall support Level 2 Conformance as defined in Section B.4.1.

484 Note

486 This requirement means that all Type 1, Type 2, and Type 3 Attributes defined in the Information Object Definition and Private Attributes associated with the SOP Class will be stored and may be accessed.

488

Add XA Defined Protocol SOP Class to GG.3

490 **GG.3 SOP Classes**

492 The application-level services addressed by the Non-Patient Object Storage Service Class definition are specified in the SOP Classes specified in Table GG.3-1.

494 **Table GG.3-1. Standard SOP Classes**

SOP Class Name	SOP Class UID	IOD Specification (defined in PS3.3)
Hanging Protocol Storage	1.2.840.10008.5.1.4.38.1	Hanging Protocol IOD
Color Palette Storage	1.2.840.10008.5.1.4.39.1	Color Palette IOD
Generic Implant Template Storage	1.2.840.10008.5.1.4.43.1	Generic Implant Template IOD
Implant Assembly Template Storage	1.2.840.10008.5.1.4.44.1	Implant Assembly Template IOD
Implant Template Group Storage	1.2.840.10008.5.1.4.45.1	Implant Template Group IOD
CT Defined Procedure Protocol Storage	1.2.840.10008.5.1.4.1.1.200.1	CT Defined Procedure Protocol IOD
Protocol Approval Storage	1.2.840.10008.5.1.4.1.1.200.3	Protocol Approval IOD
<u>XA Defined Procedure Protocol Storage</u>	<u>1.2.840.10008.5.1.4.1.1.200.X2</u>	<u>XA Defined Procedure Protocol IOD</u>

496 ***Add sections to GG.6.4 with SOP-specific details***

GG.6.4 CT-Defined Procedure Protocol Storage SOP Class

498 **GG.6.4.1 CT Defined Procedure Protocol Storage SOP Class**

500 An implementation that conforms to the CT Defined Procedure Protocol Storage SOP Class as an SCP shall not modify constraints for which the value of the Modifiable Constraint Flag (0082,0038) is NO.

Modifying protocol constraints changes the semantics of a CT Defined Procedure Protocol Storage SOP Instance.

502 **GG.6.4.X2 XA Defined Procedure Protocol Storage SOP Class**

504 **An implementation that conforms to the XA Defined Procedure Protocol Storage SOP Class as an SCP shall not modify constraints for which the value of the Modifiable Constraint Flag (0082,0038) is NO.**

506 **Modifying protocol constraints changes the semantics of a XA Defined Procedure Protocol Storage SOP Instance.**

508

510

Changes to NEMA Standards Publication PS 3.6

512

Digital Imaging and Communications in Medicine (DICOM)

Part 6: Data Dictionary

514

Add the following rows to Section 6, Table 6-1

516

Table 6-1. Registry of DICOM Data Elements

518

Tag	Name	Keyword	VR	VM	
...					
(xxxx,xxxx)	xxxxx	xxxx	XX	XX	
(xxxx,xxxx)	xxxxx	xxxx	XX	XX	
...					

520

Add the following rows to Table A-1

522

Table A-1. UID Values

UID Value	UID Name	UID Type	Part
...			
<u>1.2.840.10008.5.1.4.1.1.200.X1</u>	<u>XA Defined Procedure Protocol Storage</u>	<u>SOP Class</u>	<u>PS 3.4</u>
<u>1.2.840.10008.5.1.4.1.1.200.X2</u>	<u>XA Performed Procedure Protocol Storage</u>	<u>SOP Class</u>	<u>PS 3.4</u>
...			

524

526

528

Add the following rows to Table A-3

530

Table A-3. Context Group UID Values

Context UID	Context Identifier	Context Group Name
...		
xxxxxx	CID XXX	xxxxxx
xxxxxx	CID XXX	xxxxxx
...		

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538

Changes to NEMA Standards Publication PS 3.16

540

Digital Imaging and Communications in Medicine (DICOM)

Part 16: Content Mapping Resource

542

Add the following CIDs:

544 **CID xxxx CID Name**

Type: Extensible
 Version: 200xxxxx
 UID: 1.2.840.10008.6.1.xxx

546

548

Table CID xxxx. CID Name

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-CT Concept ID	UMLS Concept Unique ID
xxx	xxx	xxx	xxx	xxx
xxx	xxx	xxx	xxx	xxx

550

Note

xxxx.

552

Modify CID 7030 as shown:

554 **CID 7030 Institutional Departments, Units and Services**

Type: Extensible
 Version: ~~20160314~~201XXXXXX
 UID: 1.2.840.10008.6.1.817

556

558

Table CID 7030. Institutional Departments, Units and Services

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-CT Concept ID	UMLS Concept Unique ID
...				
xxx	xxx	xxx	xxx	xxx
...				

560

562 **Add the following rows to Annex D Table D-1:**

564 This Annex specifies the meanings of codes defined in DICOM, either explicitly or by reference to another part of DICOM or an external reference document or standard.

DICOM Code Definitions (Coding Scheme Designator "DCM" Coding Scheme Version "01")

566

Table D-1. DICOM Controlled Terminology Definitions

Code Value	Code Meaning	Definition	Notes
...			
XXX	XXX	XXX	
...			

568

570

Changes to NEMA Standards Publication PS 3.17

Digital Imaging and Communications in Medicine (DICOM)

572

Part 17: Explanatory Information

574 *Modify Annex AAAA and AAAA.1 to be modality-agnostic:*

576 AAAA Protocol Storage Examples and Concepts (informative)

578 The following examples are provided to illustrate the usage of the ~~CT~~ Defined and Performed Procedure Protocol IODs. They do NOT represent recommended scanning practice. In some cases they have been influenced by published protocols, but the examples here may not fully encode those published protocols and no attempt has been made to keep them up-to-date.

AAAA.1 Protocol Storage Concepts

582 AAAA.1.1 Use Cases

584 The primary applications (use cases) considered during the development of the ~~CT~~ Procedure Protocol Storage IODs were the following:

586 *Modify Annex AAAA.2 to be CT-specific:*

AAAA.2 CT Routine Adult Head Protocol

588 The examples in this Annex are intended to illustrate the encoding mechanisms of the DICOM CT Protocol Storage IODs, not to suggest particular values for clinical use. Further, these examples do not contain the many detailed attributes one would expect from a fully executable.

592 *Add new sections to AAAA for XA-specific examples:*

AAAA.X1 XA example 1

594 The examples in this Annex are intended to illustrate the encoding mechanisms of the DICOM XA Protocol Storage IODs, not to suggest particular values for clinical use.

596 ...