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Digital Imaging and Communications in Medicine (DICOM)

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Supplement 212: XA Protocol Storage

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Scope and Field of Application

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

100 The two storage SOP Classes are:

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

108 The SOP Classes address details including:

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

The primary goal is to set up the acquisition (and reconstruction) equipment, not to script the entire
116 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
118 management of instructions may be handled with other objects and services such as the Contrast Injection SR or the Modality Worklist (MWL).

120 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
122 Performed Procedure Protocol represents the actual parameters as performed during the procedure. New objects describing delayed reconstructions or delayed storage may be added to a study.

124 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
126 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
128 acquisition equipment. There is no requirement that an equipment be able to run a protocol from another equipment.

130

Changes to NEMA Standards Publication PS 3.2

132

Digital Imaging and Communications in Medicine (DICOM)

Part 2: Conformance

134

Add new SOP Classes in Table A.1-2

The SOP Classes are categorized as follows:

136

Table A.1-2. UID Values

UID Value	UID Name	Category
...		
<u>1.2.840.10008.5.1.4.1.1.200.7</u>	<u>XA Defined Procedure Protocol Storage SOP Class</u>	<u>Transfer</u>
<u>1.2.840.10008.5.1.4.1.1.200.8</u>	<u>XA Performed Procedure Protocol Storage SOP Class</u>	<u>Transfer</u>
...		

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142

Changes to NEMA Standards Publication PS 3.3

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Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

146 **Add to Section 2.6 the following reference:**

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

150 **Modify Section 3.8 as shown:**

3.8 DICOM INFORMATION OBJECT

152 ...

154 Acquisition Protocol Element A sequential component of **an the** acquisition **portion of a** protocol, that contains
 156 the **SCANNING PARAMETERS parameters** necessary to perform a single **SCAN**
 158 **acquisition**. In the case of CT, this would correspond to tube voltage, tube
 160 current, rotation time, spatial location, etc. and an Acquisition Protocol Element
 also corresponds to an XR-25 PROTOCOL ELEMENT. **In the case of XA, this**
would correspond to technical factors and control algorithms for the image
acquisition, e.g. kVp, mA, pulse width, image quality targets, rotation range,
etc.

...

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

164 ...

166 Reconstruction Protocol Element A sequential component of **a the** reconstruction **portion of a** protocol such as
 generating CT thin images or multiplanar reformats, **or generating XA 2D**
processed images and/or 3D X-Ray images.

168 ...

170 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.

...

172

174

176

Add 10.41 General Procedure Protocol Reference Macro to Section 10 as shown:

178

10 MISCELLANEOUS MACROS

180 ...

10.41 GENERAL PROCEDURE PROTOCOL REFERENCE MACRO

182 Table 10.41-1 describes the Attributes for identifying the Procedure Protocol SOP Instance and the Protocol Element related to the creation of an Instance.

184

Note: Because all the Instances in a Series are often generated from the same acquisition/reconstruction protocol, protocol is often considered at the Series level (Protocol Name (0018,1030) is in the General Series Module). It is however valid to have several Instances in the same Series where each Instance was generated using a different protocol and/or a different protocol element.

186

188

Table 10.41-1. General Procedure Protocol Reference Macro Attributes

190

Attribute Name	Tag	Type	Attribute Description
Referenced Defined Protocol Sequence	(0018,990C)	1C	Defined Procedure Protocol SOP Instance(s) that were used for this Instance. Required if this instance is a Performed Procedure Protocol that resulted from a Defined Procedure Protocol. May be present otherwise. One or more Items shall be included in this Sequence. See Section 10.41.1.
<i>>Include Table 10-11 "SOP Instance Reference Macro Attributes"</i>			
>Source Acquisition Protocol Element Number	(0018,9938)	3	A single value corresponding to the Protocol Element Number (0018,9921) of the Acquisition Protocol Element Specification Sequence (0018,991F) that corresponds to this Instance. Shall not be present if Source Reconstruction Protocol Element Number (0018,993A) is present.
>Source Reconstruction Protocol Element Number	(0018,993A)	3	A single value corresponding to the Protocol Element Number (0018,9921) of the Reconstruction Protocol Element Specification Sequence (0018,9933) that corresponds to this Instance. Shall not be present if Source Acquisition Protocol Element Number (0018,9938) is present.
Referenced Performed Protocol Sequence	(0018,990D)	1C	Performed Procedure Protocol SOP Instance(s) that describe the conditions by which this Instance was generated. Required if a related Performed Procedure Protocol

Attribute Name	Tag	Type	Attribute Description
			SOP Instance was created. One or more Items shall be included in this Sequence. See Section 10.41.1.
<i>>Include Table 10-11 "SOP Instance Reference Macro Attributes"</i>			
>Source Acquisition Protocol Element Number	(0018,9938)	3	A single value corresponding to the Protocol Element Number (0018,9921) of the Acquisition Protocol Element Sequence (0018,9920) that corresponds to this Instance. Shall not be present if Source Reconstruction Protocol Element Number (0018,993A) is present.
>Source Reconstruction Protocol Element Number	(0018,993A)	3	A single value corresponding to the Protocol Element Number (0018,9921) of the Reconstruction Protocol Element Sequence (0018,9934) that corresponds to this Instance. Shall not be present if Source Acquisition Protocol Element Number (0018,9938) is present.

192 10.41.1 General Procedure Protocol Reference

194 The Referenced Defined Protocol Sequence (0018,990C) contains a reference to the Defined Procedure Protocol
195 SOP Instance(s) and protocol element that were used to generate this Instance. The Referenced Performed Protocol
196 Sequence (0018,990D) contains a reference to the Performed Procedure Protocol SOP Instance(s) and protocol
197 element that describe the conditions by which this Instance was generated.

198 Multiple Items in the Referenced Defined Protocol Sequence (0018,990C) may represent a group case where several
199 Defined Procedure Protocols were performed together as a single Performed Procedure Protocol.

200 Multiple Items in the Referenced Performed Protocol Sequence (0018,990D) are recommended if the acquisition and
201 reconstruction were recorded in separate Performed Procedure Protocol SOP Instances. However, it is not intended
202 that this Sequence references Defined or prior Performed Protocol SOP Instances on which the current Performed
203 Procedure Protocol SOP Instance was based. Such references may be found inside the current Performed Procedure
204 Protocol SOP Instance itself.

205 In case where the acquisition and the reconstruction are done in two separate devices connected through the network,
206 the reconstruction device can use the Source Acquisition Protocol Element of the Referenced Defined Protocol to
207 determine the images that will be reconstructed with a given reconstruction protocol element.

208

210

212

214 **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>
<u>General</u> Defined CT Acquisition		<u>U</u>
Performed CT Acquisition		
<u>General</u> Defined CT Reconstruction		<u>U</u>
Performed CT Reconstruction		
<u>Performed XA Acquisition</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>

216

Modify section A.82 as shown:

218 A.82 PROCEDURE PROTOCOL INFORMATION OBJECT DEFINITIONS

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

- 220 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
- 222 **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.

224

Modify section A.82.2.3 as shown:

226 A.82.2 CT Defined Procedure Protocol IOD

...

228 A.82.2.3 CT Defined Procedure Protocol IOD Module Table

Table A.82.2.3-1. CT Defined Procedure Protocol IOD Modules

230

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

IE	Module	Reference	Usage
	General Defined CT -Acquisition	C.34.9	U
	General Defined CT -Reconstruction	C.34.11	U
	Defined Storage	C.34.13	U
	SOP Common	C.12.1	M

232

Add sections A.82.4 and A.82.5 to Annex A.82

234

A.82.4 XA Performed Procedure Protocol IOD

A.82.4.1 XA Performed Procedure Protocol IOD Description

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

A.82.4.2 XA Performed Procedure Protocol IOD Entity-Relationship Model

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

A.82.4.3 XA Performed Procedure Protocol IOD Module Table

242

Table A.82.4.3-1. 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
	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.34.16	M
Frame of Reference	Frame of Reference	C.7.4.1	M

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
	Patient Protocol Context	C.34.3	U
	Instructions	C.34.7	U
	Patient Positioning	C.34.8	U
	Performed XA Acquisition	C.34.17	U
	Performed XA Reconstruction	C.34.18	U
	Performed Storage	C.34.14	U
	SOP Common	C.12.1	M

244

A.82.5 XA Defined Procedure Protocol IOD

246 A.82.5.1 XA Defined Procedure Protocol IOD Description

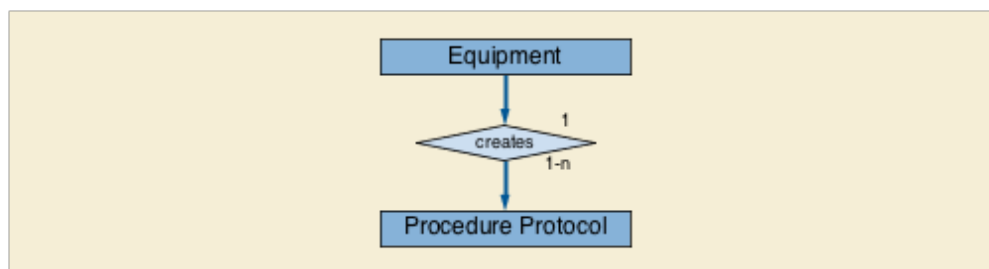
248 The XA Defined Procedure Protocol IOD describes acquisition protocol parameters and related details for a defined XA procedure.

250 See Annex AAAA "Protocol Storage Examples and Concepts (informative)" in PS3.17 for explanatory information and examples.

A.82.5.2 XA Defined Procedure Protocol IOD Entity-Relationship Model

252 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.

254 The E-R model for the XA Defined Procedure Protocol IOD is shown in Figure A.82.5.2-1.



256

Figure A.82.5.2-1. XA Defined Procedure Protocol IOD E-R Model

258

A.82.5.3 XA Defined Procedure Protocol IOD Module Table

260

Table A.82.5.3-1. 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
	General Defined Acquisition	C.34.9	U
	General Defined Reconstruction	C.34.11	U
	Defined Storage	C.34.13	U
	SOP Common	C.12.1	M

262

A.82.5.3.1 XA Defined Procedure Protocol IOD Content Constraints

A.82.5.3.1.1 Equipment Modality Attribute

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

266 Note

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

268

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

C.7 COMMON COMPOSITE IMAGE IOD MODULES

...

C.7.3.1.1.1 Modality

Defined Terms:

274 ...

	VA	Visual Acuity
276	XA	X-Ray Angiography
	XAPROTOCOL	XA Protocol (Performed)
278	XC	External-camera Photography
280	...	

282 **Modify C.8.7.1 X-Ray Image Module to include Table 10.41-1 “General Procedure Protocol Reference”**

284

C.8 MODALITY SPECIFIC MODULES

286 ...

C.8.7 X-Ray Modules

288 This Section describes Modules used in one or more X-Ray IODs. These Modules contain Attributes that are specific to X-Ray images.

290 C.8.7.1 X-Ray Image Module

292 **Table C.8-26. X-Ray Image Module Attributes**

Attribute Name	Tag	Type	Attribute Description
...			
Calibration Image	(0050,0004)	3	Indicates whether a reference object (phantom) of known size is present in the image and was used for calibration. Enumerated Values: YES NO Device is identified using the Device Module. See Section C.7.6.12.
<u>Include Table 10.41-1 “General Procedure Protocol Reference Macro Attributes”</u>			

294 **Modify C.8.19.2 Enhanced XA/XRF Image Module to include Table 10.41-1 “General Procedure Protocol Reference Macro Attributes”**

296 C.8.19.2 Enhanced XA/XRF Image Module

298 This section describes the Enhanced XA/XRF Image Module. Table C.8.19.2-1 contains IOD Attributes that describe a XA/XRF Image by specializing Attributes of the General Image Module and Image Pixel Module, and adding additional Attributes.

300 **Table C.8.19.2-1. Enhanced XA/XRF Image Module Table**

Attribute Name	Tag	Type	Attribute Description
...			
Referenced Instance Sequence	(0008,114A)	3	Non-image Composite SOP Instances that are significantly related to this Image, including waveforms that may or may not be temporally synchronized with this image. One or more Items are permitted in this Sequence.
<i>>Include Table 10-11 “SOP Instance Reference Macro Attributes”</i>			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the SOP Instances. Only a single Item shall be included in this Sequence.
<i>>>Include Table 8.8-1 “Code Sequence Macro Attributes”</i>			<i>DCID 7004 “Waveform Purposes of Reference” for referenced waveforms.</i>
<u>Include Table 10.41-1 “General Procedure Protocol Reference Macro Attributes”</u>			
Image Comments	(0020,4000)	3	User-defined comments about the image.
...			

302

304 **Modify C.8.21.1 X-Ray 3D Image Module to include Table 10.41-1 “General Procedure Protocol Reference Macro Attributes”**

C.8.21.1 X-Ray 3D Image Module

306 This section describes the X-Ray 3D Image Module. Table C.8.21.1-1 contains IOD Attributes that describe a X-Ray 3D Image by specializing Attributes of the General Image Module and Image Pixel Module, and adding additional 308 Attributes.

310 **Table C.8.21.1-1. X-Ray 3D Image Module Attributes**

Attribute Name	Tag	Type	Attribute Description
...			
Referenced Image Evidence Sequence	(0008,9092)	1C	Full set of Composite SOP Instances referred to inside the Referenced Image Sequences of this SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Referenced Image Sequence (0008,1140) is present.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
<u>Include Table 10.41-1 "General Procedure Protocol Reference Macro Attributes"</u>			
Image Comments	(0020,4000)	3	User-defined comments about the image.
...			

312

Modify Section C.34.2 as follows

314

C.34 PROCEDURE PROTOCOL MODULES

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

...

318 C.34.2 Protocol Context Module

The context in which the described Protocol is defined or performed. This Module is applicable to defined and performed procedure protocols.

322 Details like the Potential Reasons for Procedure Code Sequence (0018,9909) or the Protocol Planning Information (0018,990F) may be copied from the defined protocol into the performed protocol to support quality assurance activities like checking whether the contents of the Reason for Requested Procedure Code Sequence (0040,100A) recorded in the performed protocol are consistent with the contents of the Potential Reasons for Procedure Code Sequence (0018,9909).

326

Table C.34.2-1. Protocol Context Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			

Attribute Name	Tag	Type	Attribute Description
Contraindications Code Sequence	(0018,990B)	3	List of reasons for which the authors of the Protocol deemed it contraindicated. Note Constraints on values of patient demographic Attributes such as sex, age or weight are addressed separately in the Patient Specification Module. See Section C.34.5. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			<i>BCID 1200 "Contraindications For CT Imaging"</i> <i>BCID 1201 "Contraindications For XA Imaging"</i>
...			

328

330 **Modify Section C.34.7 as follows**

C.34.7 Instructions Module

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

Table C.34.7-1. Instructions Module Attributes

334

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 <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>1.2.840.10008.5.1.4.1.1.200.8 (XA Performed Procedure Protocol Storage)</u> Enumerated Values: YES 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.

...

336 **Modify Section C.34.8 as follows**

C.34.8 Patient Positioning Module

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

Table C.34.8-1. Patient Positioning Module Attributes

340

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.

Attribute Name	Tag	Type	Attribute Description
>Instruction Performed Flag	(0018,9918)	1C	Whether or not this instruction was performed. 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>1.2.840.10008.5.1.4.1.1.200.8 (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.
...			

...

342 **Modify Section C.34.9 to make it generic to all modalities, and add “CT” only when specific to CT**

344 **C.34.9 General Defined CT Acquisition Module**

346 Table C.34.9-1 contains a specification of acceptable values and ranges of acquisition parameters for an imaging procedure.

348 **Table C.34.9-1. General Defined CT Acquisition Module Attributes**

Attribute Name	Tag	Type	Attribute Description
Acquisition Protocol Element Specification Sequence	(0018,991F)	1	Specification of the acquisition parameters for acquisition protocol elements in an imaging procedure. There shall be one item in this sequence for each Acquisition Protocol Element in the Protocol. See Section C.34.9.1. One or more Items shall be included in this Sequence.
>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	Constraints on one or more acquisition parameters. One or more Items are permitted in this Sequence.
>>Include Table 10.25-1 “Attribute Value Constraint		For CT only Attributes defined in Table C.34.10-1 (i.e., in the Acquisition	

Attribute Name	Tag	Type	Attribute Description
<i>Macro Attributes"</i>			<p>Protocol Element Sequence (0018,9920) in the Performed CT Acquisition Module) and Private Data Elements associated with this acquisition protocol element may be specified as Selector Attributes.</p> <p><u>For XA only Attributes defined in Table C.34.17-1 (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.</u></p> <p>The semantics of values of Constraint Violation Significance (0082,0036) in the macro are assigned in Section C.34.9.3.</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.34.9.4.</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>

Note

- 350 The Performed CT Acquisition Module in the CT Performed Procedure Protocol will generally be "fully
352 populated". The General Defined ~~CT~~ Acquisition Module in the CT Defined Procedure Protocol Object may be
"sparsely populated" (i.e., contains only the Attributes the system that is specifying the protocol "cares
about").
- 354 ~~Attributes that might commonly be specified here include:~~
- 356 ~~• KVP (0018,0060)~~
 - ~~• X-Ray Tube Current in mA (0018,9330)~~
 - ~~• Revolution Time (0018,9305)~~
 - 358 ~~• Single Collimation Width (0018,9306)~~
 - ~~• Total Collimation Width (0018,9307)~~
 - 360 ~~• Spiral Pitch Factor (0018,9311)~~
 - ~~• Exposure Modulation Type (0018,9323)~~
 - 362 ~~• CT DIvol Notification Trigger (0018,9942) (See Section C.34.9.2)~~
 - ~~• DLP Notification Trigger (0018,9943)~~
 - 364 ~~• CT DIvol (0018,9345)~~

366 C.34.9.1 Acquisition Protocol Elements

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

370 An illustrative example for CT is provided in Table C.34.9-2. In this example, 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 CT X-Ray Details Sequence (0018,9325), close attention must be paid to the use of the Selector Sequence Pointer (0072,0052) in the Attribute Value Constraint Macro. ~~Illustrative examples are provided in Table C.34.9-2.~~

372 C.34.9.2 Dose Related Attributes in Parameter Specification Sequence

374 If CTDIvol Notification Trigger (0018,9942) or DLP Notification Trigger (0018,9943) are present in a parameter specification for an Acquisition Protocol Element, each is intended to communicate a Dose Check (NEMA XR-25-2010) threshold value associated with that Acquisition Protocol Element. As such, a Constraint Type (0082,0032) of EQUAL would be the most appropriate.

378 If CTDIvol (0018,9345) is present in a parameter specification for an Acquisition Protocol Element, the value is intended to communicate an estimate of the CTDIvol for that Acquisition Protocol Element. It is expected that the value would either be a single CTDIvol that represents a typical value given the parameter constraints and defaults provided, or a range that represents the expected value range if the parameters are varied within the defined constraints. The value of CTDIvol is not itself a constraint on the execution of the Protocol, but rather an estimate to help the radiologist, technologist and/or physicist when reviewing and managing sets of Protocols. Constraints and associated behaviors are provided by the CTDIvol Notification Trigger, the DLP Notification Trigger and the NEMA XR-25 Dose Check standard.

386 Note

388 It should be recognized that the formulae and methods used by any given scanner model to estimate CTDIvol may evolve over time. When such changes occur, devices that generate CT Defined Procedure Protocol instances, are advised to generate new instances using the revised estimation methods.

390 C.34.9.3 Attribute Value Constraint Macro

The ~~CT~~ Defined Procedure Protocol SOP Classes es assigns the following significance to the values of Constraint Violation Significance (0082,0036) :

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

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

398 C.34.9.4 Modifiable Constraint Flag

400 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.

402 For example, a CT device that creates a Defined Procedure Protocol, may indicate that the Element Name (0018,9922) of the Acquisition Protocol Element, or the CTDIvol Notification Trigger (0018,9942) constraints may be modified, but the Spiral Pitch Factor (0018,9311) 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 CTDIvol Notification Trigger.

408 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(s) (0018,1190) constraint may not since the latter depends on correlated changes by the device to other attributes. Such information

410 **would be useful to a protocol management workstation that is letting its operator make changes to the Element Name (0018,9922) of the Acquisition Protocol Element.**

412 Note

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

420

422

424 **Modify Table C.34.10-1 as follows**

426 C.34.10 Performed CT Acquisition Module

...

428 **Table C.34.10-1. Performed CT Acquisition Module Attributes**

Attribute Name	Tag	Type	Attribute Description
...			
>Requested Series Description	(0018,9937)	3	Requested Text that is intended to be copied into the Series Description (0008,103E) of raw instances resulting from this Acquisition Protocol Element.
<u>>Requested Series Description Code Sequence</u>	<u>(0018,11C1)</u>	<u>3</u>	<u>A code that is intended to be copied into the Series Description Code Sequence (0008,103F) of instances resulting from this Acquisition Protocol Element.</u> <u>Only a single Item is permitted in this Sequence</u>
<u>>>Include Table 8.8-1 "Code Sequence Macro Attributes"</u>			<u>No Baseline CID is defined.</u>
>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.

430 **Modify Section C.34.11 to make it generic to all modalities, and add “CT” only when specific to CT**

432 C.34.11 General Defined ~~CT~~ Reconstruction Module

434 Table C.34.11-1 contains specification of acceptable values and ranges of reconstruction parameters for an imaging procedure.

436 **Table C.34.11-1. General Defined ~~CT~~ Reconstruction Module Attributes**

Attribute Name	Tag	Type	Attribute Description
Reconstruction Protocol Element Specification Sequence	(0018,9933)	1	Specification of the parameters for 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”			<p>For CT 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.</p> <p><u>For XA only Attributes defined in Table C.34.18-1 (i.e. in the Reconstruction Protocol Element Sequence (0018,9934) in the Performed XA Reconstruction Module) and Private Data Elements associated with this reconstruction protocol element may be specified as Selector Attributes.</u></p> <p>The semantics of values of Constraint Violation Significance (0082,0036) in the Macro are assigned in Section C.34.9.3.</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	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.

~~Attributes that might commonly be specified here include:~~

- 438 ~~Reconstruction Algorithm (0018,9315)~~
- ~~Convolution Kernel (0018,1210)~~
- 440 ~~Reconstruction Diameter (0018,1100)~~
- ~~Slice Thickness (0018,0050)~~
- 442 ~~Pixel Spacing (0028,0030)~~

444 **C.34.11.1 Reconstruction Protocol Elements**

446 A ~~CT~~ Protocol ~~frequently specifies~~ may specify multiple reconstructions. For example, a CT single helical
 448 Acquisition Protocol Element may be reconstructed once as thin slices and a second time as thick slices. **Also an XA single subtracted rotational Acquisition Protocol Element may be reconstructed once as mask slices and a second time as subtracted slices.**

450

Modify Table C.34.12-1 as follows

452

C.34.12 Performed CT Reconstruction Module

454 ...

Table C.34.12-1. Performed CT Reconstruction Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			
>Requested Series Description	(0018,9937)	3	Requested text that is intended to be copied into the Series Description (0008,103E) of the images resulting from this reconstruction protocol element.
<u>>Requested Series Description Code Sequence</u>	<u>(0018,11C1)</u>	<u>3</u>	<u>A code that is intended to be copied into the Series Description Code Sequence (0008,103F) of the images resulting from this Reconstruction Protocol Element.</u> <u>Only a single Item is permitted in this Sequence</u>
<u>>>Include Table 8.8-1 "Code Sequence Macro Attributes"</u>			<u>No Baseline CID is defined.</u>
>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.

456

458 **Modify C.34.13.1 to make it generic to all modalities, not specific to CT**

C.34.13 Defined Storage Module

460 Table C.34.13-1 contains specification of acceptable values and ranges of storage parameters for an imaging
 462 procedure. Storage protocol elements may be used to automatically send the output of particular protocol elements to
 464 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.

...

466 C.34.13.1 Storage Protocol Elements

468 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.

470

472 **Modify C.34.14 to make it generic to all modalities (not specific to CT) and to add notes to (0018,9936)**

C.34.14 Performed Storage Module

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

Table C.34.14-1. Performed Storage Module Attributes

476

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><u>Notes</u></p> <p>1. 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 have configured behaviors to store output objects to a default destination or retain them locally.</p> <p>2. Similarly, whether the need to complete and record performed storage protocol elements merits delaying</p>

Attribute Name	Tag	Type	Attribute Description
			<p><u>the creation of the Performed Protocol objects in which that would be recorded is left to the discretion of the implementation.</u></p> <p><u>3. Further, there is no intention to record instance storage events that occur beyond those immediately associated with the initial acquisition and reconstruction of the study data.</u></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> <p>Required if:</p> <ul style="list-style-type: none"> • 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) <u>or 1.2.840.10008.5.1.4.1.1.200.8 (XA Performed Procedure Protocol Storage).</u> • 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.
>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>

Attribute Name	Tag	Type	Attribute Description
			Enumerated Values: 1.2.840.10008.5.1.4.1.1.200.2 CT Performed Procedure Protocol Storage 1.2.840.10008.5.1.4.1.1.200.8 XA Performed Procedure Protocol Storage
>Referenced SOP Instance UID	(0008,1155)	1C	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). Required if the referenced acquisition protocol element is not in this instance.
>Output Information Sequence	(0040,4033)	1	References to acquired and reconstructed data objects stored as part of this storage protocol element. One or more Items shall be included in this Sequence. Note 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.
>>Include Table 10-3c "Storage Macro Attributes"			

478 **Add XA Protocol Modules at the end of Section C.34 (new sections C.34.16 to C.34.18)**

C.34.16 XA Protocol Series Module

480 The XA Protocol IODs use the Section C.7.3.1 General Series Module, specialized by the XA Protocol Series Module,
 482 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.34.16-1 specifies the Attributes that describe a XA Protocol Series.

484 **Table C.34.16-1. 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.

486 ...

488 **C.34.17 Performed XA Acquisition Module**

490 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).

492 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 acquired images.

494 Note

496 The acquisition parameters for an XA imaging system are those involved in the creation of the 2D ORIGINAL pixel data. They include two different activities: the control of the X-Ray generation and beam formation to obtain the output signal from the X-Ray detector (so-called raw data), and the linear and image-independent corrections of the raw data.

500 The XA Defined Acquisition Protocol is typically selected manually from the device console, although rules may exist on the device to pre-select a default protocol based on procedure type and patient characteristics. Each Protocol Element contains the parameters of one acquisition mode. For a biplane system, the parameters for both planes are contained in the same protocol element. The operator may choose which Protocol Elements are performed during the procedure.

504 **Table C.34.17-1. Performed XA Acquisition Module Attributes**

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.
<i>>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"</i>			
<i>>Include Table 10.41-1 "General Procedure Protocol Reference Macro Attributes"</i>			
>Radiation Setting	(0018,1155)	1	Identify the general level of X-Ray dose exposure. Enumerated Values: SC Low dose exposure generally corresponding to fluoroscopic settings (e.g., preparation for diagnostic quality image acquisition) GR High dose for diagnostic quality image acquisition (also called digital spot or cine)
>Acquisition Mode	(0018,11B0)	1	Manufacturer-defined name of the acquisition mode described by this Protocol Element.

Attribute Name	Tag	Type	Attribute Description
>Scan Options	(0018,0022)	3	Identifies the acquisition technique of this Protocol Element. Defined Terms: TOMO Tomography CHASE Bolus Chasing STEP Stepping ROTA Rotation
>Dose Mode Name	(0018,11B1)	3	Manufacturer-defined name of the dose level program (e.g. High, Medium, Low).
>Acquired Subtraction Mask Flag	(0018,11B2)	3	Identifies that the device acquired mask images for subtraction. Enumerated Values: YES NO
>Fluoroscopy Persistence Flag	(0018,11B3)	3	Identifies that the device has persistently kept a block of continuously acquired fluoroscopy data. Applicable if the equipment supports local storage of fluoroscopy data. Enumerated Values: YES NO See Section C.34.17.1
>Fluoroscopy Last Image Hold Persistence Flag	(0018,11B4)	3	Identifies that the device has persistently kept the last image of the acquired fluoroscopy data. Applicable if the equipment supports local storage of Fluoro Last Image Hold data. Enumerated Values: YES NO See Section C.34.17.1
>Upper Limit Number Of Persistent Fluoroscopy Frames	(0018,11B5)	3	Upper limit of the number of fluoroscopy frames to be persistently kept.
> Contrast/Bolus Auto Injection Trigger Flag	(0018,11B6)	3	Identifies that the contrast/bolus injection was automatically controlled. Enumerated Values: YES NO
>Contrast/Bolus Injection Delay	(0018,11B7)	3	Time delay in seconds of the injection of contrast/bolus with respect to the X-Ray start. Negative values mean that injection starts before X-Ray start.
>Contrast/Bolus Ingredient Opaque	(0018,9425)	3	Whether the absorption of the contrast/bolus ingredient was greater than the absorption of water (tissue).

Attribute Name	Tag	Type	Attribute Description
			Enumerated Values: YES NO
>XA Acquisition Phase Details Sequence	(0018,11B8)	3	Parameter values for each of the phases. Each item in the sequence describes one phase. One or more Items are permitted in this sequence. See Section C.34.17.2
>>XA Acquisition Duration	(0018,11BD)	3	The time in seconds used for the acquisition of this phase.
>>XA Acquisition Frame Rate	(0018,11B9)	1	The frame rate in frames per second used for this phase.
>Planes in Acquisition	(0018,9410)	3	The multiplicity of planes that could be used simultaneously during the acquisition. See Section C.8.19.2.1.3.
>XA Plane Details Sequence	(0018,11BA)	3	Parameter values for each of the planes (or X-Ray beams) operating simultaneously in the Acquisition Protocol Element. Each item in the sequence describes one plane. One or more Items are permitted in this Sequence. Note: A Biplane system is recommended to create two items, one for each plane, even if the parameters of both planes are the same.
>>Plane Identification	(0018,9457)	1	Identification of the plane to which the parameters of this sequence item applies. Defined Terms: MONOPLANE PLANE A PLANE B
>>Beam Number	(300A,00C0)	1	Identification number of the beam. The value shall be 1 if Plane Identification (0018,9457) equals MONOPLANE or PLANE A, and shall be 2 if Plane Identification (0018,9457) equals PLANE B.
>>KVP	(0018,0060)	3	Peak kilo voltage output of the x-ray generator.
>>X-Ray Tube Current in mA	(0018,9330)	3	Nominal X-ray tube current in milliamperes.
>>Exposure Time in ms	(0018,9328)	3	Duration of exposure for this Acquisition Protocol Element in milliseconds.
>>Exposure in mAs	(0018,9332)	3	The exposure expressed in milliamperere seconds, for example calculated from Exposure Time and X-Ray Tube Current.

Attribute Name	Tag	Type	Attribute Description
>>Average Pulse Width	(0018,1154)	3	Average width of X-Ray pulse in msec.
>>Focal Spot(s)	(0018,1190)	3	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.
>>Acquisition Field of View Label	(0018,11BB)	3	Manufacturer-defined name of the Field of View label displayed on the acquisition console. Each label corresponds to a FOV dimension applied during the acquisition.
>>Field of View Dimension(s) in Float	(0018,9461)	3	Dimensions in mm of the Field of View, that is the image pixels stored in Pixel Data (7FE0,0010). If Field of View Shape (0018,1147) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of the circle circumscribing the hexagon.
>>X-Ray Filter Details Sequence	(0018,11BC)	3	Parameter values for each of the filters inserted simultaneously into the X-Ray beam. Each item in the sequence describes one filter. One or more Items shall be included in this sequence.
>>>Filter Thickness Minimum	(0018,7052)	3	The minimum thickness in mm of the X-Ray absorbing material used in the filters. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050).
>>>Filter Thickness Maximum	(0018,7054)	3	The maximum thickness in mm of the X-Ray absorbing material used in the filters. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050).
>>>Filter Type	(0018,1160)	3	Type of filter(s) inserted into the X-Ray beam (e.g., wedges). Defined Terms: STRIP WEDGE BUTTERFLY MULTIPLE FLAT NONE
>>>Filter Material	(0018,7050)	3	The X-Ray absorbing material used in the filter. Defined Terms: MOLYBDENUM ALUMINUM COPPER RHODIUM NIOBIUM

Attribute Name	Tag	Type	Attribute Description
			EUROPIUM LEAD
>>Detector Binning	(0018,701A)	3	Number of active detectors used to generate a single pixel. Specified as number of row detectors per pixel then column.
>>Bits Stored	(0028,0101)	3	Number of bits stored for each pixel sample in the acquired images.
>>Rows	(0028,0010)	3	Number of rows in the acquired images.
>>Columns	(0028,0011)	3	Number of columns in the acquired images.
>>Primary Positioner Scan Start Angle	(0018,9510)	3	Start position of the primary positioner in degrees. Applicable only to protocol elements for rotational acquisitions, i.e. Scan Options (0018,0022) equals ROTA.
>>Secondary Positioner Scan Start Angle	(0018,9511)	3	Start position of the secondary positioner in degrees. Applicable only to protocol elements for rotational acquisitions, i.e. Scan Options (0018,0022) equals ROTA.
>>Primary Positioner Scan Arc	(0018,9508)	3	Total amount of rotation of the primary positioner in degrees. Applicable only to protocol elements for rotational acquisitions, i.e. Scan Options (0018,0022) equals ROTA.
>>Secondary Positioner Scan Arc	(0018,9509)	3	Total amount of rotation of the secondary positioner in degrees. Applicable only to protocol elements for rotational acquisitions, i.e. Scan Options (0018,0022) equals ROTA.
>>Rotational Primary Angle Rotation Step	(0018,9514)	3	Constant increment of the primary positioner angle in degrees. Positive increment indicates an increasing value of the primary positioner angle. Applicable only to protocol elements for rotational acquisitions, i.e. Scan Options (0018,0022) equals ROTA.
>>Rotational Secondary Angle Rotation Step	(0018,9515)	3	Constant increment of the secondary positioner angle in degrees. Positive increment indicates an increasing value of the secondary positioner angle. Applicable only to protocol elements for rotational acquisitions, i.e. Scan Options (0018,0022) equals ROTA.
>>Rotational SID (distance source to detector)	(0018,1110)	3	Distance from source to receptor plane perpendicular to the receptor plane in mm. Applicable only to protocol elements for rotational acquisitions, i.e. Scan Options (0018,0022) equals ROTA.
>Requested Series Description	(0018,9937)	3	Text that is intended to be copied into the Series Description (0008,103E) of the images resulting from this Acquisition

Attribute Name	Tag	Type	Attribute Description
			Protocol Element.
>Requested Series Description Code Sequence	(0018,11C1)	3	A code that is intended to be copied into the Series Description Code Sequence (0008,103F) of the images resulting from this Acquisition Protocol Element. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			No Baseline CID is defined.
>Content Qualification	(0018,9004)	3	Content Qualification Indicator of instances resulting from this Acquisition Protocol Element. Enumerated Values: PRODUCT RESEARCH SERVICE See Section C.34.18.2.

506

C.34.17.1 Fluoroscopy Persistence

508 An XA device acquires fluoroscopy to be primarily displayed in real time during image-guided procedures.

510 Fluoroscopy Persistence means that the fluoroscopy pixel data is not discarded immediately after the acquisition, but rather it is kept locally on the acquisition device for further use, either to be reviewed, processed, stored on media and/or transmitted as DICOM instances to another DICOM device.

512 The attributes Fluoroscopy Persistence Flag (0018,11B3) and Fluoroscopy Last Image Hold Persistence Flag (0018,11B4) do not suggest or assume any further use of the data other than the local storage on the acquisition device. The workflows related to the presentation, processing or transmission of Fluoroscopy data is handled outside the Acquisition Protocols.

516 C.34.17.2 XA Acquisition Phase Details Sequence

518 Some systems may perform an XA acquisition by automatically changing the frame rate at predefined times during the same acquisition. An XA Acquisition Phase is defined as a collection of frames in which the acquisition frame rate remains constant. A new phase shall be defined whenever there is a change in the frame rate, new phase can be defined at the acquisition device's discretion.

522 Each XA Acquisition Phase is encoded as an Item in this Sequence. An Acquisition Element of constant frame rate for the duration of the acquisition is encoded with one single item in this Sequence.

524 An Image Instance may contain one or more phases, but an Image Instance cannot span across multiple Protocol Elements. The X-Ray switch is kept ON along all the XA Acquisition Phases within an acquisition.

526 C.34.18 Performed XA Reconstruction Module

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

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

530

532 Note: Although the protocol elements are performed in the order of their Protocol Element Number
 (0018,9921), the order in which the attributes inside an item in the Reconstruction Protocol Element
 534 Sequence (0018,9934) is not encoded here but rather is determined by the processing pipeline of the
 specific device.

536 The XA Reconstruction Protocol includes 2D and 3D processing parameters. Some parameters are applicable to both
 2D and 3D processing while other parameters are only applicable to 3D processing (e.g. slice thickness).

538 **Table C.34.18-1. Performed XA Reconstruction Module Attributes**

Attribute Name	Tag	Type	Attribute Description
Reconstruction Protocol Element Sequence	(0018,9934)	1	Parameter values for each reconstruction protocol element in the Protocol. Elements are performed in the order of their Protocol Element Number (0018,9921). One or more Items shall be included in this Sequence.
>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"			
>Include Table 10.41-1 "General Procedure Protocol Reference Macro Attributes"			
>Source Acquisition Protocol Element Number	(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.
>Source Acquisition Beam Number	(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.
>Referenced SOP Class UID	(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 1.2.840.10008.5.1.4.1.1.200.8 (XA Performed Procedure Protocol Storage)
>Referenced SOP Instance UID	(0008,1155)	1C	The UID of the instance containing the acquisition protocol element referenced in Source Acquisition Protocol Element Number (0018,9938). Required if the referenced acquisition protocol element is not in this instance.
>Reconstruction Pipeline Type	(0018,11BE)	1	Specifies the type of pipeline of the reconstruction. See Section C.34.18.1. Enumerated Values:

Attribute Name	Tag	Type	Attribute Description
			2D 3D
>Window Width	(0028,1050)	3	Preferred value for Window Center (0028,1050) in the image instances produced by this reconstruction protocol element.
>Window Center	(0028,1051)	3	Preferred value for Window Width (0028,1051) in the image instances produced by this reconstruction protocol element.
>Image Filter Details Sequence	(0018,11BF)	3	Description of image filters applied to the reconstructed image. The filters are applied in the order of the sequence items. One or more Items are permitted in this Sequence.
>>Image Filter	(0018,9320)	1	A label identifying the filter applied to the reconstructed image.
>>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, metal artifact reduction.
>Applied Mask Subtraction Flag	(0018,11C0)	3	Identifies that a subtraction mask was applied. Enumerated Values: YES NO
>Mask Visibility Percentage	(0028,9478)	3	The percentage of visibility of the mask frame during the subtraction. A value of 0 corresponds to subtracted display, a value of 100 corresponds to un-subtracted display (native). See Section C.8.19.7.1.
>Rows	(0028,0010)	3	Number of rows in the reconstructed image.
>Columns	(0028,0011)	3	Number of columns in the reconstructed image.
>Image Rotation	(0070,0042)	3	Rotation of the image clockwise in degrees, before the Image Horizontal Flip (0070,0041) is applied. Enumerated Values: 270 180 90 0
>Image Horizontal Flip	(0070,0041)	3	Whether or not the image horizontal flip is applied after any Image Rotation has been applied such that the left side of the image becomes the right side.

Attribute Name	Tag	Type	Attribute Description
			Enumerated Values: Y N
>Algorithm Type	(0018,9527)	3	Type of algorithm used to create the 3D reconstruction. Defined Terms: FILTER_BACK_PROJ ITERATIVE
>Convolution Kernel	(0018,1210)	3	A label describing the convolution kernel or algorithm used to perform 3D reconstruction of the data. A single value shall be present.
>Number Of Slices	(0054,0081)	3	Number of slices in the 3D reconstructed image.
>Slice Thickness	(0018,0050)	3	Nominal 3D reconstructed slice thickness, in mm.
>Spacing Between Slices	(0018,0088)	3	Spacing between 3D reconstructed 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 resulting from the combination of allowable values for thickness and spacing.
>Reconstruction Field of View	(0018,9317)	3	The field of view width (x-dimension) followed by height (y-dimension) as used for 3D reconstruction in mm.
>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"			No Baseline CID is defined.
>Requested Series Description	(0018,9937)	3	Text that is intended to be copied into the Series Description (0008,103E) of the images resulting from this Reconstruction Protocol Element.
>Requested Series Description Code Sequence	(0018,11C1)	3	A code that is intended to be copied into the Series Description Code Sequence (0008,103F) of the images resulting from this Reconstruction Protocol Element. Only a single Item is permitted in this Sequence
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			No Baseline CID is defined.
>Content Qualification	(0018,9004)	3	Content Qualification Indicator of instances resulting from this Reconstruction Protocol Element.

Attribute Name	Tag	Type	Attribute Description
			Enumerated Values: PRODUCT RESEARCH SERVICE See Section C.34.18.2.

540 **C.34.18.1 Reconstruction Pipeline Type**

542 Reconstruction Pipeline Type (0018,11BE) specifies the type of processing pipeline performed by the Reconstruction Protocol Element. XA processing pipelines can be categorized depending on the type of output data: 2D for the creation of 2D XA DERIVED Instances, and 3D for the creation of 3D XA Instances.

544 Note: A 3D reconstruction element may also involve 2D reconstruction details in the pipeline.

C.34.18.2 Content Qualification

546 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.

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

550

Changes to NEMA Standards Publication PS 3.4

552 Digital Imaging and Communications in Medicine (DICOM)

Part 4: Service Class Specifications

554

Add SOP Class to Table B.5-1

556 B.5 STANDARD SOP CLASSES

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

Table B.5-1. Standard SOP Classes

560

SOP Class Name	SOP Class UID	IOD Specification (defined in PS3.3)
...		
<u>XA Performed Procedure Protocol Storage</u>	<u>1.2.840.10008.5.1.4.1.1.200.8</u>	<u>XA Performed Procedure Protocol IOD</u>
...		

562 **Update section B.5.1.21 to add SCP requirements for XA Performed Procedure Protocol Storage**

B.5.1 Specialization for Standard SOP Classes

564 ...

B.5.1.21 CT and XA Performed Procedure Protocol Storage SOP Classes

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

568 For a device that is both a SCU and a SCP of the CT or 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 specified for CT and XA Performed Procedure Protocol Storage SOP Classes:

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

572 Note

574 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.

576

Add XA Defined Protocol SOP Class to GG.3
--

578 **GG.3 SOP CLASSES**

580 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.

582 **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>1.2.840.10008.5.1.4.1.1.200.7</u>	<u>XA Defined Procedure Protocol IOD</u>

584 **Modify section GG.6.4 with XA SOP Class specific details**

GG.6.4 CT and XA Defined Procedure Protocol Storage SOP Classes

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

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

590

592

594

Changes to NEMA Standards Publication PS 3.6**Digital Imaging and Communications in Medicine (DICOM)**

596

Part 6: Data Dictionary598 **Add the following rows to Section 6, Table 6-1**

600

Table 6-1. Registry of DICOM Data Elements

Tag	Name	Keyword	VR	VM	
(0018,11B0)	Acquisition Mode	AcquisitionMode	LO	1	
(0018,11B1)	Dose Mode Name	DoseModeName	LO	1	
(0018,11B2)	Acquired Subtraction Mask Flag	AcquiredSubtractionMaskFlag	CS	1	
(0018,11B3)	Fluoroscopy Persistence Flag	FluoroscopyPersistenceFlag	CS	1	
(0018,11B4)	Fluoroscopy Last Image Hold Persistence Flag	FluoroscopyLastImageHoldPersistenceFlag	CS	1	
(0018,11B5)	Upper Limit Number Of Persistent Fluoroscopy Frames	UpperLimitNumberOfPersistentFluoroscopyFrames	IS	1	
(0018,11B6)	Contrast/Bolus Auto Injection Trigger Flag	ContrastBolusAutoInjectionTriggerFlag	CS	1	
(0018,11B7)	Contrast/Bolus Injection Delay	ContrastBolusInjectionDelay	FD	1	
(0018,11B8)	XA Acquisition Phase Details Sequence	XAAcquisitionPhaseDetailsSequence	SQ	1	
(0018,11B9)	XA Acquisition Frame Rate	XAAcquisitionFrameRate	FD	1	
(0018,11BA)	XA Plane Details Sequence	XAPlaneDetailsSequence	SQ	1	
(0018,11BB)	Acquisition Field of View Label	AcquisitionFieldOfViewLabel	LO	1	
(0018,11BC)	X-Ray Filter Details Sequence	XRyFilterDetailsSequence	SQ	1	
(0018,11BD)	XA Acquisition Duration	XAAcquisitionDuration	FD	1	

Tag	Name	Keyword	VR	VM	
(0018,11BE)	Reconstruction Pipeline Type	ReconstructionPipelineType	CS	1	
(0018,11BF)	Image Filter Details Sequence	ImageFilterDetailsSequence	SQ	1	
(0018,11C0)	Applied Mask Subtraction Flag	AppliedMaskSubtractionFlag	CS	1	
(0018,11C1)	Requested Series Description Code Sequence	RequestedSeriesDescriptionCodeSequence	SQ	1	

602

604 **Add the following rows to Table A-1**606 **Table A-1. UID Values**

UID Value	UID Name	UID Keyword	UID Type	Part
1.2.840.10008.5.1.4.1.1.200.7	XA Defined Procedure Protocol Storage	XADefinedProcedureProtocolStorage	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.200.8	XA Performed Procedure Protocol Storage	XAPerformedProcedureProtocolStorage	SOP Class	PS 3.4

608

610 **Add the following rows to Table A-3**612 **Table A-3. Context Group UID Values**

Context UID	Context Identifier	Context Group Name	Comment
1.2.840.10008.6.1.1360	CID 1201	Contraindications For XA Imaging	

614

616

Changes to NEMA Standards Publication PS 3.15

618

Digital Imaging and Communications in Medicine (DICOM)

Part 15: Security and System Management Profiles

620

Modify Table E.1-1. Application Level Confidentiality Profile Attributes as follows:

622

Table E.1-1. Application Level Confidentiality Profile Attributes

624

Attribute Name	Tag	Retd. (from PS3.6)	In Std. Comp. IOD (from PS3.3)	Basic Prof.	Rtn. Safe Priv. Opt.	Rtn. UIDs Opt.	Rtn. Dev. Id. Opt.	Rtn. Inst. Id. Opt.	Rtn. Pat. Chars. Opt.	Rtn. Long. Full Dates Opt.	Rtn. Long. Modif. Dates Opt.	Clean Desc. Opt.	Clean Struct. Cont. Opt.	Clean Graph. Opt.
...														
<u>Requested Series Description</u>	<u>(0018,9937)</u>	<u>N</u>	<u>Y</u>	<u>X</u>								<u>C</u>		
...														
<u>Acquisition Field of View Label</u>	<u>(0018,11BB)</u>	<u>N</u>	<u>Y</u>	<u>D</u>								<u>C</u>		
...														

626

628

630

Changes to NEMA Standards Publication PS 3.16

Digital Imaging and Communications in Medicine (DICOM)

632

Part 16: Content Mapping Resource

634 **Add the following CID as follows:**

CID 1201 Contraindications For XA Imaging

636 The items in this context group identify possible contraindications for specific XA imaging protocols. Contraindications for XA imaging in general, irrespective of the Protocol used, are not included here.

638 **Resources:** HTML | FHIR JSON | FHIR XML | IHE SVS XML
 638 **Type:** Extensible
 640 **Version:** 20210121
 640 **UID:** 1.2.840.10008.6.1.1360

642

Table CID 1201. Contraindications For XA Imaging

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	293638001	X-ray Contrast Media Allergy	DF-10F42	C0570563
SCT	293637006	Contrast Media Allergy	DF-10F41	C0570562
SCT	77386006	Patient currently pregnant	F-84000	C0549206
SCT	236423003	Impaired Renal Function	D7-11007	C1565489
SCT	64779008	Blood Coagulation Disorders	DC-60000	C0005779
SCT	698247007	Cardiac Arrhythmia	R-FAE6C	C0003811
SCT	91302008	Sepsis	DE-00020	C0243026

644

[Ed. Note: SNOMED Request ID#759292 to add 64779008, 91302008]

646

648

650

Changes to NEMA Standards Publication PS 3.17

Digital Imaging and Communications in Medicine (DICOM)

652

Part 17: Explanatory Information

654 *Modify Annex AAAA as follows:*

AAAA Protocol Storage Examples and Concepts (informative)

656 The following examples are provided to illustrate the usage of the ~~CT~~-Defined and Performed Procedure Protocol IODs. They do ~~NOT~~ not represent recommended scanning practice. In some cases they have been influenced by
658 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

AAAA.1.1 Use Cases

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

664 ...

AAAA.1.2 Workflow

666 ...

AAAA.1.3 XA Workflow

668 On the XA Modality, the operator modifies the protocols and their parameters directly on the console at
670 tablesides. XA procedures are not fully planned in advance, they are interactive because the operator's actions
will depend on real-time information from the live images, and on how the patient reacts to the intervention.

672 Typically the operator changes acquisition modes (e.g. Fluoroscopy, DSA, Rotational) and acquisition
parameters (e.g. Field of View, frame rate, IQ/Dose levels). During the procedure the operator may need to
674 change the protocols to switch to low-dose programs or to potentially modify the anatomy being imaged. The
patient position on the table may change depending on the patient's size and type of procedure.

676 In some cases, several XA multi-frame images of different protocols and anatomies are acquired with the
same patient position and stored within the same Series. Different Series may be created as other Series
attributes have changed during the procedure (e.g. Patient Position).

678 Several Performed Protocol Elements may be recorded for the same Defined Protocol Element used.

AAAA.2 CT Routine Adult Head Protocol

680 The examples in this Annex are intended to illustrate the encoding mechanisms of the DICOM CT Protocol Storage
682 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 defined protocol generated by a CT scanner, but they do
demonstrate the usage of many common Attributes.

684 ...

686 **Add new sections to Annex AAAA for XA Protocol examples:**

688 AAAA.4 Single XA Device for Acquisition and Reconstruction

689 This example is intended to illustrate the encoding mechanisms of the DICOM XA Protocol Storage IODs, not to
690 suggest particular values for clinical use. Further, this example does not contain the many detailed Attributes one
691 would expect from a fully executable defined protocol generated by an XA device, but it demonstrates the usage of
692 many common Attributes.

693 This section includes one Defined Protocol example of an Adult Carotid Stenting Protocol for one XA device model,
694 developed for a fictitious Mercy Hospital. It contains the following protocol elements:

- Three Acquisition Protocol Elements corresponding to Fluoroscopy, DSA and Rotational acquisition modes.
- One Reconstruction Protocol Element corresponding to the 3D reconstruction of the rotational acquisition images.

698

AAAA.4.1 Common Context

700 Table AAAA.4-1 contains the attributes that are basically the same for each model of equipment from the same
manufacturer. The Table AAAA.4-2 contains the attributes specific to one model of equipment.

702

Table AAAA.4-1. Adult Carotid Stenting Protocol - Context

Attribute	Tag	Value
Equipment Modality	(0008,0221)	XA
Custodial Organization Sequence	(0040,A07C)	
>Institution Name	(0008,0800)	Mercy Hospital
Responsible Group Code Sequence	(0008,0220)	(708174004, SCT, "Interventional Radiology Service")
Protocol Name	(0018,1030)	Carotid Stenting
Potential Requested Procedure Code Sequence	(0018,9907)	(103716009, SCT, "Stent placement")...
Contraindications Code Sequence	(0018,990B)	(293638001, SCT, "X-ray Contrast Media Allergy")
Instruction Sequence	(0018,9914)	
>Instruction Index	(0018,9915)	1
>Instruction Text	(0018,9916)	"Start with fluoroscopy. See Instruction Description."
>Instruction Description	(0018,9917)	Frame Rate: 7.5 frames/second

Attribute	Tag	Value
		Breathing Technique: No Breath Hold
>Instruction Index	(0018,9915)	2
>Instruction Text	(0018,9916)	"Follow by one or more DSA acquisitions. See Instruction Description."
>Instruction Description	(0018,9917)	Breathing Technique: Breath Hold Contrast: Omnipaque 350 or Visipaque 320, based on Creatine Clearance Injection: 4ml per second for 10ml total for 6 french catheters. 3ml per second for 8ml total for 4 French Catheters. FOV: 20 cm Table Height: Above IRP
>Instruction Index	(0018,9915)	3
>Instruction Text	(0018,9916)	"Follow by one rotational acquisition. See Instruction Description."
>Instruction Description	(0018,9917)	Breathing Technique: Breath Hold Contrast: Omnipaque 350 or Visipaque 320, based on Creatine Clearance Injection: 13ml per second for 39ml total for 6 french catheters. FOV: 30 cm Table Height: Carotid at Isocenter
Protocol Defined Patient Position	(0018,9947)	HFS
Anatomic Region Sequence	(0008,2218)	(774007, SCT, "Head and Neck")

704

AAAA.4.2 Angiotech Industries

706 The first part of this example is shown above in Table AAAA.4-1.

Table AAAA.4-2. Adult Carotid Stenting Protocol - Details - Angiotech

708

Attribute	Tag	Value
Model Specification Sequence	(0018,9912)	
>Manufacturer	(0008,0070)	Angiotech
>Manufacturer's Related Model Group	(0008,0222)	Angiomatic
>Software Versions	(0018,1020)	v.XA01
Patient Specification Sequence	(0018,9911)	

Attribute	Tag	Value
<i>>See Table AAAA.4-2a "Patient Specification"</i>		
Acquisition Protocol Element Specification Sequence	(0018,991F)	
>Protocol Element Number	(0018,9921)	1
>Parameters Specification Sequence	(0018,9913)	
<i>>>See Table AAAA.4-2b "First Acquisition Protocol Element Specification - FLUOROSCOPY NOSUB"</i>		
>Protocol Element Number	(0018,9921)	2
>Parameters Specification Sequence	(0018,9913)	
<i>>>See Table AAAA.4-2c "Second Acquisition Protocol Element Specification - DSA"</i>		
>Protocol Element Number	(0018,9921)	3
>Parameters Specification Sequence	(0018,9913)	
<i>>>See Table AAAA.4-2d "Third Acquisition Protocol Element Specification - ROTATIONAL SUB"</i>		
Reconstruction Protocol Element Specification Sequence	(0018,9933)	
>Protocol Element Number	(0018,9921)	1
>Parameters Specification Sequence	(0018,9913)	
<i>>>See Table AAAA.4-2e "First Reconstruction Protocol Element Specification - 3D SUB RECONSTRUCTION"</i>		

710 The following tables reflect the semantic contents of constraint sequences but not the actual structure of the IOD. The rows in italics clarify the context of the constrained Attributes that follow by indicating which sequence in the performed module contains the constrained Attribute (as specified in the Selector Sequence Pointer).

712 In this example, the 3D reconstruction is performed on each image acquired with the protocol element number 3. This is indicated in the attribute Source Acquisition Protocol Element Number (0018,9938) of the Reconstruction Protocol
714 Element.

716 Note that for multi-valued Selector Attributes like Field of View Dimension(s) in Float (0018,9461), a Selector Value Number (0072,0028) with the value 0 means that the constraint applies to all the values of the Attribute.

Table AAAA.4-2a. Patient Specification

718

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
Patient's Age	(0010,1010)	1	absent	absent	GREATER_THAN	"18Y"

720 **Table AAAA.4-2b. First Acquisition Protocol Element Specification – FLUOROSCOPY**
722 **NOSUB**

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
<i>Acquisition Protocol Element Sequence (0018,9920)</i>						
Protocol Element Number	(0018,9921)	1	(0018,9920)	1	EQUAL	1
Protocol Element Name	(0018,9922)	1	(0018,9920)	1	EQUAL	"FLUOROSCOPY NOSUB"
Radiation Setting	(0018,1155)	1	(0018,9920)	1	EQUAL	SC
Acquisition Mode	(0018,11B0)	1	(0018,9920)	1	EQUAL	"Fluoroscopy"
Acquired Subtraction Mask Flag	(0018,11B2)	1	(0018,9920)	1	EQUAL	NO
<i>>XA Acquisition Phase Details Sequence (0018,11B8)</i>						
XA Acquisition Frame Rate	(0018,11B9)	1	(0018,9920)\ (0018,11B8)	1	EQUAL	7.5
Planes in Acquisition	(0018,9410)	1	(0018,9920)	1	EQUAL	SINGLE PLANE
<i>>XA Plane Details Sequence (0018,11BA)</i>						
Plane Identification	(0018,9457)	1	(0018,9920)\ (0018,11BA)	1\1	EQUAL	MONOPLANE
Beam Number	(300A,00C0)	1	(0018,9920)\ (0018,11BA)	1\1	EQUAL	1
Field of View Dimension(s) in Float	(0018,9461)	0	(0018,9920)\ (0018,11BA)	1\1	RANGE_INCL	120.0, 300.0
<i>>>X-Ray Filter Details Sequence (0018,11BC)</i>						
Filter Thickness Minimum	(0018,7052)	1	(0018,9920)\ (0018,11BA)\ (0018,11BC)	1\1\1	EQUAL	0.5
Filter Thickness Maximum	(0018,7054)	1	(0018,9920)\ (0018,11BA)\ (0018,11BC)	1\1\1	EQUAL	1.0

724

Table AAAA.4-2c. Second Acquisition Protocol Element Specification – DSA

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
<i>Acquisition Protocol Element Sequence (0018,9920)</i>						
Protocol Element Number	(0018,9921)	1	(0018,9920)	2	EQUAL	2
Protocol Element Name	(0018,9922)	1	(0018,9920)	2	EQUAL	"DSA"
Radiation Setting	(0018,1155)	1	(0018,9920)	2	EQUAL	GR
Acquisition Mode	(0018,11B0)	1	(0018,9920)	2	EQUAL	"DSA"
Acquired Subtraction Mask Flag	(0018,11B2)	1	(0018,9920)	2	EQUAL	YES
Planes in Acquisition	(0018,9410)	1	(0018,9920)	2	EQUAL	SINGLE PLANE
<i>>XA Plane Details Sequence (0018,11BA)</i>						
Plane Identification	(0018,9457)	1	(0018,9920)\ (0018,11BA)	2\1	EQUAL	MONOPLANE
Beam Number	(300A,00C0)	1	(0018,9920)\ (0018,11BA)	2\1	EQUAL	1
Field of View Dimension(s) in Float	(0018,9461)	0	(0018,9920)\ (0018,11BA)	2\1	RANGE_INCL	120.0, 300.0
<i>>>X-Ray Filter Details Sequence (0018,11BC)</i>						
Filter Thickness Minimum	(0018,7052)	1	(0018,9920)\ (0018,11BA)\ (0018,11BC)	2\1\1	EQUAL	0.5
Filter Thickness Maximum	(0018,7054)	1	(0018,9920)\ (0018,11BA)\ (0018,11BC)	2\1\1	EQUAL	1.0

726

Table AAAA.4-2d. Third Acquisition Protocol Element Specification - ROTATIONAL SUB

728

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
<i>Acquisition Protocol Element Sequence (0018,9920)</i>						
Protocol Element Number	(0018,9921)	1	(0018,9920)	3	EQUAL	3
Protocol Element Name	(0018,9922)	1	(0018,9920)	3	EQUAL	"ROTATIONAL SUB"
Radiation Setting	(0018,1155)	1	(0018,9920)	3	EQUAL	GR

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
Acquisition Mode	(0018,11B0)	1	(0018,9920)	3	EQUAL	"Rotational"
Acquired Subtraction Mask Flag	(0018,11B2)	1	(0018,9920)	3	EQUAL	YES
Planes in Acquisition	(0018,9410)	1	(0018,9920)	3	EQUAL	SINGLE PLANE
<i>>XA Plane Details Sequence (0018,11BA)</i>						
Plane Identification	(0018,9457)	1	(0018,9920)\(0018,11BA)	3\1	EQUAL	MONOPLANE
Beam Number	(300A,00C0)	1	(0018,9920)\(0018,11BA)	3\1	EQUAL	1
Field of View Dimension(s) in Float	(0018,9461)	0	(0018,9920)\(0018,11BA)	3\1	EQUAL	300.0
Primary Positioner Scan Start Angle	(0018,9510)	1	(0018,9920)\(0018,11BA)	3\1	EQUAL	-100
Primary Positioner Scan Arc	(0018,9508)	1	(0018,9920)\(0018,11BA)	3\1	EQUAL	200
Rotational Primary Angle Rotation Step	(0018,9514)	1	(0018,9920)\(0018,11BA)	3\1	EQUAL	0.5
<i>>>X-Ray Filter Details Sequence (0018,11BC)</i>						
Filter Thickness Minimum	(0018,7052)	1	(0018,9920)\(0018,11BA)\(0018,11BC)	3\1\1	EQUAL	1.0
Filter Thickness Maximum	(0018,7054)	1	(0018,9920)\(0018,11BA)\(0018,11BC)	3\1\1	EQUAL	1.0

730

Table AAAA.4-2e. First Reconstruction Protocol Element Specification - 3D SUB RECONSTRUCTION

732

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
<i>Reconstruction Protocol Element Sequence (0018,9934)</i>						
Protocol Element Number	(0018,9921)	1	(0018,9934)	1	EQUAL	1
Protocol Element Name	(0018,9922)	1	(0018,9934)	1	EQUAL	"3D SUB RECONSTRUCTION"

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
Source Acquisition Protocol Element Number	(0018,9938)	1	(0018,9934)	1	EQUAL	3
Source Acquisition Beam Number	(0018,9939)	1	(0018,9934)	1	EQUAL	1
Reconstruction Pipeline Type	(0018,11BE)	1	(0018,9934)	1	EQUAL	"3D"
Applied Mask Subtraction Flag	(0018,11C0)	1	(0018,9934)	1	EQUAL	"YES"
Rows	(0028,0010)	1	(0018,9934)	1	EQUAL	512
Columns	(0028,0011)	1	(0018,9934)	1	EQUAL	512
Algorithm Type	(0018,9527)	1	(0018,9934)	1	EQUAL	"FILTER_BACK_PROJ"
Number Of Slices	(0054,0081)	1	(0018,9934)	1	EQUAL	512
Slice Thickness	(0018,0050)	1	(0018,9934)	1	EQUAL	0.2
Reconstruction Field of View	(0018,9317)	0	(0018,9934)	1	EQUAL	300.0
<i>>Image Filter Details Sequence (0018,11BF)</i>						
Image Filter	(0018,9320)	1	(0018,9934)\(0018,11BF)	1\1	EQUAL	"Metal_MEDIUM"
Image Filter Description	(0018,9941)	1	(0018,9934)\(0018,11BF)	1\1	EQUAL	"Metal artifact removal"

734 AAAA.5 Two XA Devices for Acquisition and Reconstruction

736 This example is intended to illustrate the encoding mechanisms of the DICOM XA Protocol Storage IODs, not to
737 suggest particular values for clinical use. Further, this example does not contain the many detailed Attributes one
738 would expect from a fully executable defined protocol generated by an XA device, but it demonstrates the usage of
some common Attributes.

740 This section includes an example of two Defined Procedure Protocols, one in the acquisition device, the other in the
741 3D reconstruction device. This example illustrates the workflow where the user selects one acquisition protocol on the
742 acquisition device, acquires one rotational image, this image is sent to the 3D reconstruction device, and the 3D
reconstruction is performed based on the protocol references of the image header.

744 AAAA.5.1 Acquisition and Storage Protocol

746 Table AAAA.5-1 contains some attributes of the Defined Procedure Protocol in the acquisition device, showing its SOP
Instance UID which will be referenced further on the images and on the protocol in the 3D Reconstruction workstation.
This table includes the acquisition and storage protocol elements.

748

Table AAAA.5-1. Acquisition and Storage Protocol

750

Attribute	Tag	Value
SOP Class UID	(0008,0016)	1.2.840.10008.5.1.4.1.1.200.7 (XA Defined Procedure Protocol Storage)
SOP Instance UID	(0008,0018)	UID_01
Acquisition Protocol Element Specification Sequence	(0018,991F)	
>Protocol Element Number	(0018,9921)	3
>Parameters Specification Sequence	(0018,9913)	
<i>>>See Table AAAA.5-1a "Third Acquisition Protocol Element Specification - ROTATIONAL SUB ACQ"</i>		
Storage Protocol Element Specification Sequence	(0018,9935)	
>Protocol Element Number	(0018,9921)	1
>Parameters Specification Sequence	(0018,9913)	
<i>>>See Table AAAA.5-1b "First Storage Protocol Element Specification – SEND TO 3D WS"</i>		

752 The following tables reflect the semantic contents of constraint sequences but not the actual structure of the IOD. The rows in italics clarify the context of the constrained Attributes that follow by indicating which sequence in the performed module contains the constrained Attribute (as specified in the Selector Sequence Pointer).

754 In this example, the acquisition device includes the acquisition protocol element for the rotational acquisition, as well
756 as one storage protocol element to send to the 3D Workstation all the images acquired with the rotational Acquisition Element #3. This is indicated in the attribute Source Acquisition Protocol Element Number (0018,9938) of the Storage Protocol Element.

758 **Table AAAA.5-1a. Third Acquisition Protocol Element Specification - ROTATIONAL SUB ACQ**

760

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
<i>Acquisition Protocol Element Sequence (0018,9920)</i>						
Protocol Element Number	(0018,9921)	1	(0018,9920)	1	EQUAL	3
Protocol Element Name	(0018,9922)	1	(0018,9920)	1	EQUAL	"ROTATIONAL SUB ACQ"
Acquisition Mode	(0018,11B0)	1	(0018,9920)	1	EQUAL	"Rotational"

762

Table AAAA.5-1b. First Storage Protocol Element Specification – SEND TO 3D WS

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
<i>Storage Protocol Element Sequence (0018,9936)</i>						
Protocol Element Number	(0018,9921)	1	(0018,9936)	1	EQUAL	1
Protocol Element Name	(0018,9922)	1	(0018,9936)	1	EQUAL	"SEND TO 3D WS"
Protocol Element Purpose	(0018,9924)	1	(0018,9936)	1	EQUAL	"For 3D Reconstruction"
Source Acquisition Protocol Element Number	(0018,9938)	1	(0018,9936)	1	EQUAL	3
<i>>Output Information Sequence (0040,4033)</i> <i>>>DICOM Retrieval Sequence (0040,4071)</i>						
Destination AE	(2100,0140)	1	(0018,9936)\ (0040,4033)\ (0040,4071)	1\1\1	EQUAL	"AET_3D_WS"

764

766 **AAAA.5.2 Rotational XA Image**

768 Table AAAA.5-2 contains some attributes of the XA Image Instance acquired with the Acquisition Element #3 of the
 770 protocol SOP Instance UID "UID_01" of the acquisition device. This is indicated in the attributes Referenced SOP
 Instance UID (0008,1155) and Source Acquisition Protocol Element Number (0018,9938) of the Referenced Defined
 Protocol Sequence (0018,990C).

772

Table AAAA.5-2. Rotational Image

Attribute	Tag	Value
SOP Class UID	(0008,0016)	1.2.840.10008.5.1.4.1.1.12.1 (X-Ray Angiographic Image Storage)
SOP Instance UID	(0008,0018)	UID_02
Referenced Defined Protocol Sequence	(0018,990C)	
>Referenced SOP Class UID	(0008,1150)	1.2.840.10008.5.1.4.1.1.200.7 (XA Defined Procedure Protocol Storage)
>Referenced SOP Instance UID	(0008,1155)	UID_01
>Source Acquisition Protocol Element Number	(0018,9938)	3

774 **AAAA.5.3 Reconstruction Protocol**

776 Table AAAA.5-3 contains some attributes of the Defined Procedure Protocol in the 3D reconstruction workstation, that includes the Reconstruction Protocol Element.

778 **Table AAAA.5-3. Reconstruction Protocol**

Attribute	Tag	Value
SOP Class UID	(0008,0016)	1.2.840.10008.5.1.4.1.1.200.7 (XA Defined Procedure Protocol Storage)
SOP Instance UID	(0008,0018)	UID_03
Reconstruction Protocol Element Specification Sequence	(0018,9933)	
>Protocol Element Number	(0018,9921)	1
>Parameters Specification Sequence	(0018,9913)	
>>See Table AAAA.5-3a "First Reconstruction Protocol Element Specification - 3D SUB RECONSTRUCTION"		

780 The following table reflects the semantic contents of constraint sequences but not the actual structure of the IOD. The rows in italics clarify the context of the constrained Attributes that follow by indicating which sequence in the performed module contains the constrained Attribute (as specified in the Selector Sequence Pointer).

782 In this example, the reconstruction device includes the Reconstruction Protocol Element to perform the 3D reconstruction of all the images acquired with the rotational Acquisition Element #3 of the protocol SOP Instance UID "UID_01" in the acquisition device. This is indicated in the attribute Source Acquisition Protocol Element Number (0018,9938) and Referenced SOP Instance UID (0008,1155).

786 **Table AAAA.5-3a. First Reconstruction Protocol Element Specification - 3D SUB RECONSTRUCTION**

788

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
<i>Reconstruction Protocol Element Sequence (0018,9934)</i>						
Protocol Element Number	(0018,9921)	1	(0018,9934)	1	EQUAL	1
Protocol Element Name	(0018,9922)	1	(0018,9934)	1	EQUAL	"3D SUB RECONSTRUCTION"
Source Acquisition Protocol Element Number	(0018,9938)	1	(0018,9934)	1	EQUAL	3
Referenced SOP Class UID	(0008,1150)	1	(0018,9934)	1	EQUAL	1.2.840.10008.5.1.4.1.1.200.7 (XA Defined Procedure Protocol

Attribute	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Constraint Type	Constraint Value
						Storage)
Referenced SOP Instance UID	(0008,1155)	1	(0018,9934)	1	EQUAL	UID_01

790