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Digital Imaging and Communications in Medicine (DICOM)

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Supplement 212: XA Protocol Storage

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Table of Contents

	Table of Contents	2
32	DOCUMENT HISTORY	4
	Scope and Field of Application	5
34	OPEN ISSUES	6
	CLOSED ISSUES	6
36	Changes to NEMA Standards Publication PS 3.2	8
	Changes to NEMA Standards Publication PS 3.3	9
38	3.8 DICOM INFORMATION OBJECT	9
	10 MISCELLANEOUS MACROS	10
40	10.X1 REFERENCED PROCEDURE PROTOCOLS MACRO	10
	10.X1.1 Referenced Procedure Protocols Sequence	12
42	A.82 PROCEDURE PROTOCOL INFORMATION OBJECT DEFINITIONS	13
	A.82.Y1 XA Performed Procedure Protocol IOD	13
44	A.82.Y1.1 XA Performed Procedure Protocol IOD Description	13
	A.82.Y1.2 XA Performed Procedure Protocol IOD Entity-Relationship Model	13
46	A.82.Y1.3 XA Performed Procedure Protocol IOD Module Table	13
	A.82.Y2 XA Defined Procedure Protocol IOD	14
48	A.82.Y2.1 XA Defined Procedure Protocol IOD Description	14
	A.82.Y2.2 XA Defined Procedure Protocol IOD Entity-Relationship Model	15
50	A.82.Y2.3 XA Defined Procedure Protocol IOD Module Table	15
	A.82.Y2.3.1 XA Defined Procedure Protocol IOD Content Constraints	16
52	A.82.Y2.3.1.1 Equipment Modality Attribute	16
	C.7 COMMON COMPOSITE IMAGE IOD MODULES	16
54	C.7.3.1.1.1 Modality	16
	C.8 MODALITY SPECIFIC MODULES	16
56	C.8.7 X-Ray Modules	16
	C.8.7.1 X-Ray Image Module	16
58	C.8.7.1.1 X-Ray Image Attribute Descriptions	17
	C.8.7.1.1.X1 Referenced Procedure Protocols Macro Attributes	17
60	C.8.19.2 Enhanced XA/XRF Image Module	17
	C.8.21.1 X-Ray 3D Image Module	18
62	C.34 PROCEDURE PROTOCOL MODULES	19
	C.34.2 Protocol Context Module	19
64	C.34.7 Instructions Module	19
	C.34.8 Patient Positioning Module	20
66	C.34.13 Defined Storage Module	22
	C.34.13.1 Storage Protocol Elements	23
68	C.34.14 Performed Storage Module	23
	C.34.X1 XA Protocol Series Module	25
70	C.34.X2 Defined XA Acquisition Module	25
	C.34.X2.1 Acquisition Protocol Elements	27
72	C.34.X2.2 Attribute Value Constraint Macro	27
	C.34.X2.3 Modifiable Constraint Flag	28
74	C.34.X3 Performed XA Acquisition Module	28
	C.34.X3.1 Acquisition Segment Details Sequence	32
76	C.34.X3.2 XA Plane Details Sequence	32
	C.34.X3.3 Filter Details Sequence	32
78	C.34.X4 Defined XA Reconstruction Module	32
	C.34.X4.1 Reconstruction Protocol Elements	33

80	C.34.X5 Performed XA Reconstruction Module	33
	C.34.X5.1 Content Qualification	37
82	C.34.X5.2 Reconstruction Purpose	37
	C.34.X5.3 Image Filter Details Sequence.....	37
84	Changes to NEMA Standards Publication PS 3.4.....	38
	B.5 STANDARD SOP CLASSES.....	38
86	B.5.1 Specialization for Standard SOP Classes.....	38
	B.5.1.X1 XA Performed Procedure Protocol Storage SOP Class	38
88	GG.3 SOP CLASSES	39
	GG.6.4 CT-Defined Procedure Protocol Storage SOP Class.....	39
90	GG.6.4.1 CT Defined Procedure Protocol Storage SOP Class.....	39
	GG.6.4.2 XA Defined Procedure Protocol Storage SOP Class.....	39
92	Changes to NEMA Standards Publication PS 3.6.....	40
	Changes to NEMA Standards Publication PS 3.16	42
94	CID 1200 Contraindications For CT Imaging.....	42
	Changes to NEMA Standards Publication PS 3.17	43
96	AAAA CT Protocol Storage Examples and Concepts (informative)	43
	XXXX XA Protocol Storage Examples and Concepts (informative)	43
98	XXXX.1 Protocol Storage Concepts	43
	XXXX.1.1 Use Cases.....	43
100	XXXX.1.2 Workflow.....	44
	XXXX.2 Single XA Device for Acquisition and Reconstruction	44
102	XXXX.3 Two XA Devices for Acquisition and Reconstruction.....	44
104	XXXX.4 QA and Best Practice Defined Procedure Protocol	44

106

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: - 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
Draft 16	April 3, 2019	Updated for the Public Comments version at WG-02 April meeting in New York (US)
Draft 17	May 29, 2019	Updates to prepare WG-06 review in June 2019.
Draft 18	June 03, 2019	To be reviewed with WG-06 in June 04, 2019
Draft 18 WIP	June 05, 2019 End Of Day	Updated after WG-06 meeting. WG-06 review stopped the line-by-line review at the line 216. The Open and Closed Issues were not reviewed. Yellow highlights is To Be Done before the next WG-06 meeting.

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110

Scope and Field of Application

112 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.

114 The two storage SOP Classes are:

- 116 • **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
118 a certain acquisition equipment model and/or version (identified by device attributes in the protocol), but model-non-specific protocols are not prohibited.
- 120 • **XA Performed Procedure Protocol Storage** SOP Class that describes the values actually used in a performed procedure. Performed protocols are patient-specific.

122 The SOP Classes address details including:

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

The primary goal is to set up the acquisition (and reconstruction) equipment, not to script the entire
130 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
132 management of instructions may be handled with other objects and services such as the Contrast Injection SR or the Modality Worklist (MWL).

134 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
136 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.

138 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
140 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
142 acquisition equipment. There is no requirement that an equipment be able to run a protocol from another equipment.

144

OPEN ISSUES

04	<p>Q: It's understood that the Reconstruction Protocol Elements are intended to process data to be stored locally on the system. However, in XA there's also a need to process the pixels only to be exported, not to be stored locally (e.g. subsampling, cropping, compression, format change e.g. JPEG, exporting every two images, etc.).</p> <p>There's a need to add a list of processing parameters to be applied on-the-fly during storage. Where should this list be defined? In the Reconstruction protocol or in the Storage protocol? How to specify that this is only for on-the-fly processing?</p> <p>A:</p>
05	<p>Q: As opposed to CT, various XA images may be acquired and processed (reconstructed) under the same defined protocol element, while the operator changes the values of some control parameters (e.g. mask subtraction).</p> <p>A defined storage protocol element should be able to indicate that only a subset of these images should be exported (e.g. only subtracted). To allow this, it is needed to include attributes in the Storage Protocol Element to be used as matching keys to decide what images must be stored within the same protocol element.</p> <p>A:</p>

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CLOSED ISSUES

01	<p>Q: Should it be a supplement for XA/XRF Protocols? Or only XA?</p> <p>A: WG-02 proposed only for XA. XRF might be considered later on.</p>
03	<p>Q: Reconstruction Protocol Elements includes 2D XA processing parameters. The term "Reconstruction" in XA is typically used for cone-beam 3D reconstruction, not for 2D XA imaging when there's no 3D reconstruction.</p> <p>A: In XA Protocols, the term "Reconstruction" will mean the creation of an image after the raw data has been acquired, no matter whether it is a 2D or a 3D image. With this definition, any image processing parameter (2D and 3D) will be considered a parameter for reconstruction. In the Standard, the 2D processing parameters are defined within the same module and same sequence as the 3D reconstruction parameters, but in the implementation of the protocol object the 2D and 3D parameters will appear in two different elements of the sequence.</p>
06	<p>Q: Is there a need in XA to add new CIDs or new codes to the CID 7030 Institutional Departments, Units and Services?</p> <p>A: No, existing codes do already cover the XA scenario.</p>

07	<p>Q: How can we find the Performed Protocol Instance UID for a given XA multi-frame image? DICOM defines protocols at the Series level. XA practice often includes several multi-frame images in the same Series where each image was generated using different protocol. The protocol attributes are allowed to be multi-valued. DICOM requires that Series level attributes have the same values for all images within the Series, so all the images could list all the protocols, but only one of these protocols was used to create one image.</p> <p>A: The approach is to put the Protocol Instance UID at Image level: Sup212 has added a Referenced Procedure Protocols Macro with references to the protocols and elements, then has included this macro at image level for XA (in the X-Ray Image Module, Enhanced XA/XRF Image Module, and X-Ray 3D Image Module).</p> <p>See Section 10.X1</p>
08	<p>Q: How do we reference the Protocol <u>Element</u> performed during the creation of a single XA multi-frame image?</p> <p>The General Series Module includes the attributes Referenced Defined Protocol Sequence (0018,990C) and Referenced Performed Protocol Sequence (0018,990D) but not the elements. And there is no means to reference Protocol Elements in any Image Module.</p> <p>A: The approach is to put the Protocol Element at Image level: Sup212 has added a Referenced Procedure Protocols Macro with references to the protocols and elements, then has included this macro at image level for XA (in the X-Ray Image Module, Enhanced XA/XRF Image Module, and X-Ray 3D Image Module).</p> <p>See Section 10.X1</p>
09	<p>Q: Need a generic CID for “Contraindications For Imaging”, not specific to CT</p> <p>A: Change the CID 1200 title to make it generic, and no specific to CT: CID 1200 “Contraindications For CT Imaging”.</p>

150 **Items To Do:**

- Add explanations to Section 10.X1.1 Referenced Procedure Protocols Sequence

- Add examples in Part 3.17 Section XXXX

154

Changes to NEMA Standards Publication PS 3.2

156

Digital Imaging and Communications in Medicine (DICOM)

Part 2: Conformance

158 **Add new SOP Classes in Table A.1-2**

The SOP Classes are categorized as follows:

160

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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166

Changes to NEMA Standards Publication PS 3.3

168

Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

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

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

174 **Modify Section 3.8 as shown:**

3.8 DICOM INFORMATION OBJECT

176 ...

178	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 for the image acquisition, e.g. kVp, mA, pulse width, image quality targets, rotation range, etc.</u>
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180 ...

186	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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188 ...

190	Reconstruction_Protocol_Element	A sequential component of a the reconstruction portion of a protocol such as generating CT thin images or multiplanar reformats, <u>or generating XA 2D processed images and/or 3D X-Ray images.</u>
-----	---------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

192 ...

194	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.
-----	--------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

196 ...

196

198 **Add 10.X1 Referenced Protocols Macro to Section 10 as shown:**

200 **10 MISCELLANEOUS MACROS**

...

202 **10.X1 REFERENCED PROCEDURE PROTOCOLS MACRO**

204 Table 10-X1 describes the Attributes for identifying Procedure Protocol SOP Instance(s) and Protocol Elements related to the creation of an Instance.

206 DICOM defines protocols at the Series level, i.e. the General Series Module includes the attributes Referenced Defined Protocol Sequence (0018,990C) and Referenced Performed Protocol Sequence (0018,990D). The protocol attributes are allowed to be multi-valued. DICOM requires that Series level attributes have the same values for all 208 images within the Series, so all the images could list all the protocols.

210 The practice in some modalities (E.g. XA) include several images in the same Series where each image may be generated using a different protocol and/or a different protocol element. The Series includes the list of all protocols, but not the elements.

212

214 **Table 10-X1. Referenced Procedure Protocols Macro Attributes**

Attribute Name	Tag	Type	Attribute Description
Referenced Procedure Protocols Sequence	(xxxx,xx90)	3	Procedure Protocol SOP Instance(s) and Protocol Element(s) related to the generation and description of this Instance.
>Referenced Defined Protocol Sequence	(0018,990C)	1C	<p>Defined Procedure Protocol SOP Instance(s) that were used to create this Instance.</p> <p>Required if this instance is a Performed Procedure Protocol that resulted from a Defined Procedure Protocol.</p> <p>May be present otherwise.</p> <p>One or more Items shall be included in this Sequence.</p> <p>See Section 10.X1.1</p> <p>Note</p> <p>Multiple Items in this Sequence may represent a group case where several Defined Procedure Protocols were performed together as a single Performed Procedure Protocol.</p>
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Source Acquisition Protocol Element Number	(0018,9938)	1C	<p>A value corresponding to the Protocol Element Number (0018,9921) of the Acquisition Protocol Element Specification Sequence (0018,991F) that was used to create this Instance.</p> <p>Required if this instance resulted from a Protocol Element of the Acquisition Protocol Element Specification Sequence.</p> <p>This may be multi-valued if multiple Protocol Element</p>

Attribute Name	Tag	Type	Attribute Description
			Numbers are combined to create this Instance.
>>Source Reconstruction Protocol Element Number	(0018,993A)	1C	<p>A value corresponding to the Protocol Element Number (0018,9921) of the Reconstruction Protocol Element Specification Sequence (0018,9933) that was used to create this Instance.</p> <p>Required if this instance resulted from a Protocol Element of the Reconstruction Protocol Element Specification Sequence.</p> <p>This may be multi-valued if multiple Protocol Element Numbers are combined to create this Instance.</p>
>Referenced Performed Protocol Sequence	(0018,990D)	1C	<p>Uniquely identifies the Performed Procedure Protocol SOP Instance(s) that describe the conditions by which this Instance was generated.</p> <p>Required if a related Performed Procedure Protocol SOP Instance was created.</p> <p>Only one Item shall be included in this Sequence.</p> <p>See Section 10.X1.1</p> <p>Note</p> <p>If the acquisition and reconstruction were recorded in separate Performed Procedure Protocol SOP Instances, it is recommended to reference both. However, it is not intended that this Sequence references Defined or prior Performed Protocol SOP Instances on which the current Performed Procedure Protocol SOP Instance was based. Such references may be found inside the Performed Procedure Protocol SOP Instance itself.</p>
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Source Acquisition Protocol Element Number	(0018,9938)	1C	<p>A value corresponding to the Protocol Element Number (0018,9921) of the Acquisition Protocol Element Sequence (0018,9920) that describes the conditions by which this Instance was generated.</p> <p>Required if there is an Acquisition Protocol Element that describes the conditions by which this Instance was generated.</p>
>>Source Reconstruction Protocol Element Number	(0018,993A)	1C	<p>A value corresponding to the Protocol Element Number (0018,9921) of the Reconstruction Protocol Element Sequence (0018,9934) that describes the conditions by which this Instance was generated.</p> <p>Required if there is a Reconstruction Protocol Element that describes the conditions by which this Instance was generated.</p>

216 **10.X1.1 Referenced Procedure Protocols Sequence**

218 TO DO: today, in CT there is no link between the Performed Acquisition Element and the Instances
 218 created (in CT, those are the Raw Data)... and also the Instances don't reference the defined and
 220 performed elements. Consider a Macro that could be used at Series level (for CT) and at Image Level
 220 (XA).

222 **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>
<u>Performed XA Reconstruction</u>	<u>U</u>	
Defined Storage		<u>U</u>
Performed Storage	<u>U</u>	
Protocol Approval		
SOP Common	<u>M</u>	<u>M</u>

224

Modify section A.82 as shown:

226 A.82 PROCEDURE PROTOCOL INFORMATION OBJECT DEFINITIONS

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

228 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
 230 ~~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.

232

234 **Add sections A.82.Y1 and A.82.Y2 to Annex A.82**

236 A.82.Y1 XA Performed Procedure Protocol IOD

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

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

240 A.82.Y1.2 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.

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

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

244

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.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

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

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

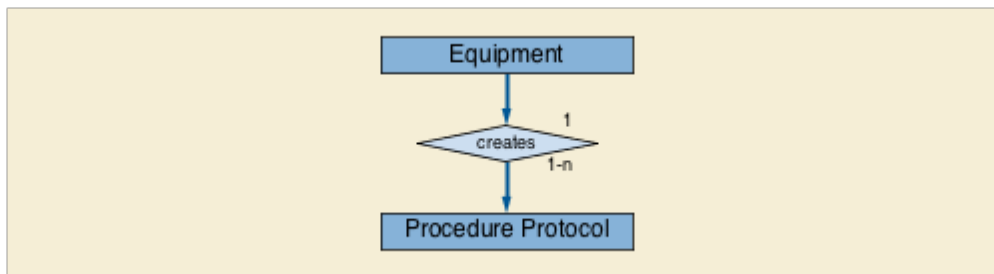
- 248 The XA Defined Procedure Protocol IOD describes acquisition protocol parameters and related details for a defined XA procedure.
- 250 See Annex AAAA "Protocol Storage Examples and Concepts (informative)" in PS3.17 for explanatory information and examples.

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

254 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.

256



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

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

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

262

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

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

A.82.Y2.3.1.1 Equipment Modality Attribute

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

Note

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

270

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

272

C.7 COMMON COMPOSITE IMAGE IOD MODULES

274 ...

C.7.3.1.1.1 Modality

276 Defined Terms:

...

278 **XAPROTOCOL** **XA Protocol (Performed)**

...

280

Modify C.8.7.1 X-Ray Image Module to include Table 10.X1 "Referenced Procedure Protocols Macro Attributes"

282

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.

C.8.7.1 X-Ray Image Module

290

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

Attribute Name	Tag	Type	Attribute Description
			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.X1 "Referenced Procedure Protocols Macro Attributes"</u>			<u>See Section C.8.7.1.1.X1</u>

292

C.8.7.1.1 X-Ray Image Attribute Descriptions

294 ...

C.8.7.1.1.X1 Referenced Procedure Protocols Macro Attributes

296 Several Images in the same Series may be generated using different protocols and/or different protocol elements.

298 The Referenced Procedure Protocols Macro Attributes allows referencing the Defined and Performed Procedure Protocol SOP Instance(s) and Protocol Element(s) that were used to create each Image. Any
 300 protocol referenced here shall also be referenced at Series level in the attributes Referenced Defined Protocol Sequence (0018,990C) and Referenced Performed Protocol Sequence (0018,990D).

302

304 *Modify C.8.19.2 Enhanced XA/XRF Image Module to include Table 10.X1 "Referenced Procedure Protocols Macro Attributes"*

C.8.19.2 Enhanced XA/XRF Image Module

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

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

310

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.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
>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.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			DCID 7004 "Waveform Purposes of Reference" for referenced waveforms.
<u>Include Table 10.X1 "Referenced Procedure Protocols Macro Attributes"</u>			<u>.See Section C.8.7.1.1.X1</u>
Image Comments	(0020,4000)	3	User-defined comments about the image.
...			

312 **Modify C.8.21.1 X-Ray 3D Image Module to include Table 10.X1 "Referenced Procedure Protocols Macro Attributes"**

314 C.8.21.1 X-Ray 3D Image Module

316 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 Attributes.

318 **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.X1 "Referenced Procedure Protocols Macro Attributes"</u>			<u>.See Section C.8.7.1.1.X1</u>
Image Comments	(0020,4000)	3	User-defined comments about the image.
...			

320

Modify XA Section C.34.2 as follows

322

C.34 PROCEDURE PROTOCOL MODULES

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

...

326

C.34.2 Protocol Context Module

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

330 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).

Table C.34.2-1. Protocol Context Module Attributes

336

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"			BCID 1200 "Contraindications For CT Imaging".
...			

338

340

Modify XA Section C.34.7 as follows

C.34.7 Instructions Module

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

344

Table C.34.7-1. Instructions Module Attributes

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) • <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)	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.

346 ...

Modify XA Section C.34.8 as follows

348 **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.

350

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 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 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.
...			

352 ...

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

C.34.13 Defined Storage Module

356 Table C.34.13-1 contains specification of acceptable values and ranges of storage parameters for an imaging
 358 procedure. Storage protocol elements may be used to automatically send the output of particular protocol elements to
 360 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.

362 **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 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.X2.2 (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 (for CT) and C.34.X2.3 (for XA) . 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 be specified here include:

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

C.34.13.1 Storage Protocol Elements

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

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

C.34.14 Performed Storage Module

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

Table C.34.14-1. Performed Storage Module Attributes

376

Attribute Name	Tag	Type	Attribute Description
Storage Protocol Element Sequence	(0018,9936)	1	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. See Section C.34.13.1. One or more Items shall be included in this Sequence. The performing system might not support the requested storage protocol or not be configured for the desired destination. Note 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.
>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"			
>Source Acquisition Protocol Element Number	(0018,9938)	1C	A value corresponding to the Element Number (0018,9921) of the Acquisition Protocol Element for which data is stored. Note 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). This may be multivalued if multiple acquisition protocol element data are being stored together. Required if Source Reconstruction Protocol Element Number (0018,993A) is not present.

Attribute Name	Tag	Type	Attribute Description
>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) or 1.2.840.10008.5.1.4.1.1.200.X2 (XA 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.
>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:</p> <p>1.2.840.10008.5.1.4.1.1.200.2 CT Performed Procedure Protocol Storage</p> <p><u>1.2.840.10008.5.1.4.1.1.200.X2 XA Performed Procedure Protocol Storage</u></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>

Attribute Name	Tag	Type	Attribute Description
>>Include Table 10-3c "Storage Macro Attributes"			

378 **Add XA Protocol Modules at the end of Section C.34 (new sections C.34.X1 to C.34.X5)**

C.34.X1 XA Protocol Series Module

380 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.

384 **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.

386 ...

388 C.34.X2 Defined XA Acquisition Module

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

392 **Table C.34.X2-1. Defined XA 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.X2.1. 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.

Attribute Name	Tag	Type	Attribute Description
>>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 Section C.34.X2.2.</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.X2.3.</p> <p>Enumerated Values:</p> <p>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>

Note1

394 The Performed XA Acquisition Module in the XA Performed Procedure Protocol will generally be "fully
396 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").

398 Note2

400 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: on one side the control of the X-Ray generation and beam
402 formation to obtain the output signal from the X-Ray detector (so-called raw data), and on the other side the
linear and Image-Independent corrections of the raw data. The raw data is not intended to be kept for re-
processing once the 2D ORIGINAL has been created.

404 Refer to IEC 62220-1-3 definitions of linear and image-independent corrections of the RAW DATA, e.g.
replacement of the RAW DATA of bad or defective pixels by appropriate data; a flat-field correction
406 comprising correction of the non-uniformity of the RADIATION FIELD; correction for the offset of the
individual pixels; and gain correction for the individual pixels; a correction for geometrical distortion.

408 Attributes that might commonly be specified here include:

- Field of View Name (xxxx,xx13)
- 410 • Acquisition Frame Rate (xxxx,xx11)
- Average Pulse Width (0018,1154)
- 412 • Focal Spot(s) (0018,1190)
- Filter Thickness (xxxx,xx15)
- 414 • Detector Binning (0018,701A)
- Auto Injection Trigger Flag (xxxx,xx08)

416

C.34.X2.1 Acquisition Protocol Elements

418 An XA Protocol usually includes more than one Acquisition Protocol Element. For example, a Coronary Pediatric Protocol might include three elements: Fluoroscopy Low Dose, Dynamic, and Rotational Non-Subtracted.

420 Since all parameters will be nested inside an Acquisition Protocol Element Sequence (0018,9920) and some of the parameters will be further nested inside an XA Plane Details Sequence (xxxx,xx12), and even further in a Filter Details Sequence (xxxx,xx14), 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.X2-2.

424 **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 Protocol Element Name (0018,9922) of the first item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,9922)	1	(0018,9920)	1	EQUAL "High Dose Fluoro"
Constrain the value of Scan Options (0018,0022) of the second item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,0022)	1	(0018,9920)	2	EQUAL "ROTA"
Constrain the value of Average Pulse Width (0018,1154) of the first plane in the XA Plane Details Sequence (xxxx,xx12) of the second item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,1154)	1	(0018,9920), (xxxx,xx12)	2\1	RANGE_INCL(10, 30)
Constrain the value of Filter Type (0018,1160) of the second filter in the Filter Details Sequence (xxxx,xx14) of the first plane in the XA Plane Details Sequence (xxxx,xx12) of the third item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,1160)	1	(0018,9920), (xxxx,xx12), (xxxx,xx14)	3\1\2	EQUAL "WEDGE"
Constrain the first and second value of Detector Binning (0018,701A) of the second plane in the XA Plane Details Sequence (xxxx,xx12) of the fourth item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,701A)	1	(0018,9920), (xxxx,xx12)	4\2	EQUAL "2"
	(0018,701A)	2	(0018,9920), (xxxx,xx12)	4\2	EQUAL "2"

426

C.34.X2.2 Attribute Value Constraint Macro

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

- 430 • 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.
- 432 • 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.
- 434 If the attribute is absent, a value of INFORMATIVE may be assumed.

C.34.X2.3 Modifiable Constraint Flag

- 436 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.
- 438

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 would be useful to a protocol management workstation that is letting its operator make changes to the Focal Spot(s).

440

442

Note

- 444 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.
- 446
- 448

450 C.34.X3 Performed XA Acquisition Module

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).

452

454 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.

456 **Table C.34.X3-1. 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.X2.1. Zero or more Items shall be included in this Sequence.
<i>>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"</i>			
>Applicable Radiation Dose Type	(xxxx,xx01)	1	Type of radiation to which the parameters of this Protocol Element are applicable. Defined Values: FLUOROSCOPY RADIOLOGY

Attribute Name	Tag	Type	Attribute Description
>Acquisition Mode Name	(xxxx,xx02)	1	<p>Manufacturer-defined name of the acquisition mode to which the parameters of this Protocol Element are applicable. It shall contain only one value. For example:</p> <p><u>For fluoroscopy:</u> FLUORO SUB, FLUORO NOSUB, HIGH DOSE ROADMAP, LOW DOSE ROADMAP, FLUORO BLENDED, etc...</p> <p><u>For Radioscopy:</u> DSA, CHASE, DYNAMIC, ROTATIONAL, SINGLE SHOT, etc...</p>
>Scan Options	(0018,0022)	3	<p>Identifies the acquisition technique of the acquisition mode of this Protocol Element.</p> <p>Defined Terms:</p> <p>TOMO Tomography CHASE Bolus Chasing STEP Stepping ROTA Rotation</p>
>Dose Mode Name	(xxxx,xx03)	3	<p>Manufacturer-defined name of the dose level program (e.g. High, Medium, Low).</p>
>Acquisition Subtraction Flag	(xxxx,xx04)	3	<p>Identifies subtraction mode at the creation of the image, indicating whether the acquisition includes mask image(s).</p> <p>Defined Terms:</p> <p>YES NO</p>
>Fluoro Storage Flag	(xxxx,xx05)	1C	<p>Identifies local storage of a block of continuously acquired fluoroscopy data. Required if the equipment supports local storage of fluoroscopy data.</p> <p>Enumerated Values:</p> <p>YES NO</p>
>Fluoro Last Image Hold Storage Flag	(xxxx,xx06)	3	<p>Identifies local storage of the last image of the acquired fluoroscopy data.</p> <p>Enumerated Values:</p> <p>YES NO</p>
>Fluoro Storage Number Of Frames	(xxxx,xx07)	3	<p>Number of frames stored during fluoroscopy.</p>
>Auto Injection Trigger Flag	(xxxx,xx08)	3	<p>Identifies whether the injection is automatically controled.</p> <p>Enumerated Values:</p> <p>YES NO</p>
>Contrast/Bolus Injection Delay	(xxxx,xx09)	3	<p>Time delay in seconds of the injection of contrast with respect</p>

Attribute Name	Tag	Type	Attribute Description
			of the X-Ray start. Negative values means that injection starts before X-Ray.
>Contrast/Bolus Ingredient	(0018,1048)	3	Active ingredient of agent. Defined Terms: IODINE GADOLINIUM CARBON DIOXIDE BARIUM
>Contrast Flow Rate	(0018,1046)	3	Rate(s) of injection(s) in milliliters/sec.
>Contrast Flow Duration	(0018,1047)	3	Duration of injection in seconds. Each Contrast Flow Duration value shall correspond to a value of Contrast Flow Rate (0018,1046).
>Acquisition Segment Details Sequence	(xxxx,xx10)	1	Parameter values for each of the segments. Each item in the sequence describes one segment. One or more Items shall be included in this sequence. See Section C.34.X3.1
>>Acquisition Duration	(0018,9073)	1	The time in seconds needed for the acquisition of this acquisition segment.
>>Acquisition Frame Rate	(xxxx,xx11)	1	The frame rate in frames per seconds needed for this acquisition segment.
>Planes in Acquisition	(0018,9410)	1	The multiplicity of planes that could be used simultaneously during the acquisition. See Section C.8.19.2.1.3.
>XA Plane Details Sequence	(xxxx,xx12)	3	Parameter values for each of the planes (or X-Ray beams) in the Acquisition Protocol Element. Each item in the sequence describes one plane. See Section C.34.X3.2 One or more Items shall be included 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 (or plane).

Attribute Name	Tag	Type	Attribute Description
>>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.
>>Average Pulse Width	(0018,1154)	3	Average width of X-Ray pulse in msec.
>>Radiation Mode	(0018,115A)	3	Specifies X-Ray radiation mode. Defined Terms: CONTINUOUS PULSED
>>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.
>>Field Of View Name	(xxxx,xx13)	3	Manufacturer-defined name.
>>Filter Details Sequence	(xxxx,xx14)	3	Parameter values for each of the filters. Each item in the sequence describes one filter. One or more Items shall be included in this sequence. See Section C.34.X3.3
>>>Filter Thickness	(xxxx,xx15)	3	The thickness in mm of the X-Ray absorbing material used in the filter.
>>>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 EUROPIUM LEAD

Attribute Name	Tag	Type	Attribute Description
>>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.
>>Pixel depth encoding	(0028,0101)	3	Number of bits stored for each pixel sample.
>>Primary Positioner Scan Start Angle	(0018,9510)	3	Applicable to rotational acquisitions.
>>Secondary Positioner Scan Start Angle	(0018,9511)	3	Applicable to rotational acquisitions.
>>Primary Positioner Scan Arc	(0018,9508)	3	Applicable to rotational acquisitions.
>>Secondary Positioner Scan Arc	(0018,9509)	3	Applicable to rotational acquisitions.
>>Rotational Primary Angle Rotation Step	(0018,9514)	3	Applicable to rotational acquisitions.
>>Rotational Secondary Angle Rotation Step	(0018,9515)	3	Applicable to rotational acquisitions.
>>Rotational SID (distance source to detector)	(0018,1110)	3	Applicable to rotational acquisitions.

458

C.34.X3.1 Acquisition Segment Details Sequence

460 Some systems perform Acquisition Protocol Elements with multiple consecutive time segments, each segment having a given duration in time and specific parameters like frame rate. Such segments are encoded with multiple Items in this Sequence.

C.34.X3.2 XA Plane Details Sequence

464 Some XA systems perform Acquisition Protocol Elements with multiple planes (i.e. multiple X-Ray beams) operating simultaneously. Such acquisitions are encoded with multiple items in this sequence.

C.34.X3.3 Filter Details Sequence

468 Some systems perform Acquisition Protocol Elements with multiple X-Ray filters simultaneously. Such filters are encoded with multiple items in this sequence.

C.34.X4 Defined XA Reconstruction Module

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

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

474

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

Attribute Name	Tag	Type	Attribute Description
			protocol element in the Protocol. See Section C.34.X4.1. 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.X5-1 (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. 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.X2.3. 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:

- 476
- Mask Subtraction Flag (xxxx,xx19)
 - Image Flip (xxxx,xx22)
- 478
- Filter Percentage (0028,9411)
 - Slice Thickness (0018,0050)
- 480
- Number Of Slices (0054,0081)

482 C.34.X4.1 Reconstruction Protocol Elements

484 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

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

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

490 **Table C.34.X5-1. 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"			
>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 one of the following 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)
>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 Purpose	(xxxx,xx16)	1	Specifies the purpose of the reconstruction pipeline. See Section C.34.X5.2. Defined Terms: 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

Attribute Name	Tag	Type	Attribute Description
			image instances produced by this reconstruction protocol element.
>Image Filter Details Sequence	(xxxx,xx17)	3	One or more items. Each item describes a type of filter applied. See Section C.34.X5.3.
>>Image Filter	(0018,9320)	3	A label describing the filter applied to the reconstructed image. E.g. sharpening, noise removing, edge enhancing, metal artifact reduction.
>>Image Filter Description	(0018,9941)	3	A description of the nature or effect of the Image Filter (0018,9320).
>>Image Filter Strength	(xxx,xx18)	3	A label or number indicating the strength or level of the filter applied to the reconstructed image. E.g. High, Medium, Low
>>Image Filter Percentage	(0028,9411)	3	Edge enhancement filter percentage applied to the reconstructed image. The value of 100 corresponds to the maximum filter strength that can be applied by a specific application displaying the image.
>Acquisition Device Processing Description	(0018,1400)	3	Indication in human readable text of the digital processing on the reconstructed images. Examples of this processing are: edge enhanced, subtracted, time filtered, gamma corrected, convolved (spatially filtered).
>Mask Subtraction Flag	(xxxx,xx19)	3	Identifies the subtraction of mask image(s) applied to the reconstructed image. Defined Terms: 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.
>2D Reconstruction Details Sequence	(xxxx,xx20)	3	Includes parameters specific to the 2D image processing. Only one item is allowed. See Section C.34.X5.2.
>> Image Horizontal Flip Flag	(xxxx,xx21)	3	Identifies the horizontal flip applied to the reconstructed

Attribute Name	Tag	Type	Attribute Description
			image. Defined Terms: YES NO
>>Image Vertical Flip Flag	(xxxx,xx22)	3	Identifies the vertical flip applied to the reconstructed image. Defined Terms: YES NO
>3D Reconstruction Details Sequence	(xxxx,xx23)	3	Includes parameters specific to the 3D reconstruction. Only one item is allowed. See Section C.34.X5.2.
>>Algorithm Type	(0018,9527)	3	Type of algorithm used to create the reconstruction. Defined Terms: FILTER_BACK_PROJ ITERATIVE
>>Convolution Kernel	(0018,1210)	3	A label describing the convolution kernel or algorithm used to reconstruct the data. A single value shall be present.
>>Number Of Slices	(0054,0081)	1	Number of slices in the reconstructed image.
>>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 resulting from the combination of allowable values for thickness and spacing.
>>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. 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.

Attribute Name	Tag	Type	Attribute Description
>Derivation Code Sequence	(0008,9215)	3	Additional processing applied to the reconstructed image after image filter (if any)
<i>>Include Table 8.8-1 "Code Sequence Macro Attributes"</i>			
>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.X5.1.

C.34.X5.1 Content Qualification

492 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.

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

496 C.34.X5.2 Reconstruction Purpose

498 Reconstruction Purpose (xxxx,xx16) specifies the category of processing pipeline performed by the Reconstruction Protocol Element. Different processing pipelines are designed in the XA systems, they can be categorized depending on the purpose and/or usage of the output data. Two basic categories are defined: the creation of 2D DERIVED
500 Instances and the creation of 3D Instances.

502 The Reconstruction Purpose (xxxx,xx16) allows identifying the ownership of the Reconstruction Protocol Elements within the system. For instance, the creation of 3D Instances will be the responsibility of the 3D reconstruction component or workstation.

504 The Reconstruction Purpose (xxxx,xx16) does not imply the presence or absence of the 2D Reconstruction Details Sequence (xxxx,xx20) or the 3D Reconstruction Details Sequence (xxxx,xx23). Indeed, the purpose of 3D
506 reconstruction may involve some processing of the 2D images before performing the 3D reconstruction.

508 C.34.X5.3 Image Filter Details Sequence

510 Some data processing performed by the Reconstruction Protocol Elements may include the sequential application of image filters. Such filters are encoded with multiple items in this sequence, the filters are applied in the order of the sequence items.

512

514

Changes to NEMA Standards Publication PS 3.4

Digital Imaging and Communications in Medicine (DICOM)

516

Part 4: Service Class Specifications

518 *Add SOP Class to Table B.5-1*

B.5 STANDARD SOP CLASSES

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

522

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>
...		

524

526 *Add new section to B.5.1.X1 to describe SCP requirements for XA Performed Procedure Protocol Storage*

528 B.5.1 Specialization for Standard SOP Classes

...

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

532 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.

534 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 specified for XA Performed Procedure Protocol Storage SOP Classes:

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

Note

538 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.

540

542 **Add XA Defined Protocol SOP Class to GG.3**

GG.3 SOP CLASSES

544 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.

546

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>

548

Add sections to GG.6.4 with SOP Class specific details

550 **GG.6.4 CT-Defined Procedure Protocol Storage SOP Class**

GG.6.4.1 CT Defined Procedure Protocol Storage SOP Class

552 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.

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

GG.6.4.2 XA Defined Procedure Protocol Storage SOP Class

556 **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.**

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

560

562

564

Changes to NEMA Standards Publication PS 3.6

Digital Imaging and Communications in Medicine (DICOM)

566

Part 6: Data Dictionary

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

570

Table 6-1. Registry of DICOM Data Elements

Tag	Name	Keyword	VR	VM	
...					
(xxxx,xx01)	Applicable Radiation Dose Type	ApplicableRadiationDoseType	CS	1	
(xxxx,xx02)	Acquisition Mode Name	AcquisitionModeName	LO	1	
(xxxx,xx03)	Dose Mode Name	DoseModeName	LO	1	
(xxxx,xx04)	Acquisition Subtraction Flag	AcquisitionSubtractionFlag	CS	1	
(xxxx,xx05)	Fluoro Storage Flag	FluoroStorageFlag	CS	1	
(xxxx,xx06)	Fluoro Last Image Hold Storage Flag	FluoroLastImageHoldStorageFlag	CS	1	
(xxxx,xx07)	Fluoro Storage Number Of Frames	FluoroStorageNumberOfFrames	IS	1	
(xxxx,xx08)	Auto Injection Trigger Flag	AutoInjectionTriggerFlag	CS	1	
(xxxx,xx09)	Contrast/Bolus Injection Delay	Contrast/BolusInjectionDelay	FL	1	
(xxxx,xx10)	Acquisition Segment Details Sequence	AcquisitionSegmentDetailsSequence	SQ	1	
(xxxx,xx11)	Acquisition Frame Rate	AcquisitionFrameRate	FL	1	
(xxxx,xx12)	XA Plane Details Sequence	XAPlaneDetailsSequence	SQ	1	
(xxxx,xx13)	Field Of View Name	FieldOfViewName	LO	1	
(xxxx,xx14)	Filter Details Sequence	FilterDetailsSequence	SQ	1	

Tag	Name	Keyword	VR	VM	
(xxxx,xx15)	Filter Thickness	FilterThickness	FL	1	
(xxxx,xx16)	Reconstruction Purpose	ReconstructionPurpose	CS	1	
(xxxx,xx17)	Image Filter Details Sequence	ImageFilterDetailsSequence	SQ	1	
(xxxx,xx18)	Image Filter Strength	ImageFilterStrength	LO	1	
(xxxx,xx19)	Mask Subtraction Flag	MaskSubtractionFlag	CS	1	
(xxxx,xx20)	2D Reconstruction Details Sequence	2DReconstructionDetailsSequence	SQ	1	
(xxxx,xx21)	Image Horizontal Flip Flag	ImageHorizontalFlipFlag	CS	1	
(xxxx,xx22)	Image Vertical Flip Flag	ImageVerticalFlipFlag	CS	1	
(xxxx,xx23)	3D Reconstruction Details Sequence	3DReconstructionDetailsSequence	SQ	1	
(xxxx,xx90)	Referenced Procedure Protocols Sequence	ReferencedProcedureProtocolsSequence	SQ	1	

572

574 **Add the following rows to Table A-1**

Table A-1. UID Values

576

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>
...			

578

580

582

Changes to NEMA Standards Publication PS 3.16

Digital Imaging and Communications in Medicine (DICOM)

584

Part 16: Content Mapping Resource

586 **Modify the following CID as follows:**

CID 1200 Contraindications For ~~CT~~ Imaging

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

590 **Resources:** HTML | FHIR JSON | FHIR XML | IHE SVS XML
 591 **Type:** Extensible
 592 **Version:** 20160905XXXXX
 593 **UID:** 1.2.840.10008.6.1.1131

594

Table CID 1200. Contraindications For ~~CT~~ Imaging

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SRT <u>SCT</u>	DF-10F42-293638001	X-ray Contrast Media Allergy	293638001-DF-10F42	C0570563
SRT <u>SCT</u>	DF-10F41-293637006	Contrast Media Allergy	293637006-DF-10F41	C0570562
SRT <u>SCT</u>	F-84000-77386006	Patient currently pregnant	77386006-F-84000	C0549206
SRT <u>SCT</u>	D7-11007-236423003	Impaired Renal Function	236423003-D7-11007	C1565489
<u>SCT</u>	<u>64779008</u>	<u>Blood Coagulation Disorders</u>		
<u>SCT</u>	<u>698247007</u>	<u>Cardiac Arrhythmia</u>		
<u>SCT</u>	<u>91302008</u>	<u>Sepsis</u>		

596

598

600

Changes to NEMA Standards Publication PS 3.17

Digital Imaging and Communications in Medicine (DICOM)

602

Part 17: Explanatory Information

604

Modify Annex AAAA as follows:

AAAA CT Protocol Storage Examples and Concepts (informative)

606 The following examples are provided to illustrate the usage of the CT Defined and Performed Procedure Protocol
607 IODs. They do NOT represent recommended scanning practice. In some cases they have been influenced by
608 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.

610 ...

612

Add new Annex XXXX for XA Protocol examples:

XXXX XA Protocol Storage Examples and Concepts (informative)

614 The following examples are provided to illustrate the usage of the XA Defined and Performed Procedure Protocol
615 IODs. They do NOT represent recommended acquisition, processing or reconstruction practice. In some cases they
616 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.

XXXX.1 Protocol Storage Concepts

XXXX.1.1 Use Cases

620 The primary applications (use cases) considered during the development of the XA Procedure Protocol
Storage IODs were the following:

- 622 • Managing protocols within a site for consistency and dose management (Using Defined Protocols)
- 624 • Recording protocol details for a performed study so the same or similar values can be used when
performing followup (Using Performed Protocols)
- 626 • Vendor troubleshooting image quality issues that may be due to poor protocol/technique (Using
Performed Protocols, Defined Protocols)
- 628 • Distributing departmental, "best practice" or reference protocols (such as AAPM) to modality
systems (Using Defined Protocols)
- 630 • Backing up protocols from a modality to PACS or removable media (e.g., during system upgrades
or replacement); most vendors have a proprietary method for doing this which would essentially
become redundant when Protocol Management is implemented (Using Defined Protocols)
- 632 • Improving imaging consistency in terms of repeatable technique, performance, quality and image
634 characteristics; would benefit from associated image quality metrics and other physics work (Using
Defined Protocols and Performed Protocols)

- 636 • Tracking/extracting details of Performed Protocol for QA, data mining, etc. (Using Performed Protocols)

638 **XXXX.1.2 Workflow**

638 TO DO: describe specific XA workflow

640 **XXXX.2 Single XA Device for Acquisition and Reconstruction**

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

644 TO DO: add example: One Defined Protocol with three protocols elements (Acquisition, Reconstruction, Storage) on the Acq System.

646 **XXXX.3 Two XA Devices for Acquisition and Reconstruction**

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

650 TO DO: add example: One protocol on both Acq and Recon devices: Two elements applicable to the Acq System (Acquisition, Storage) and two elements applicable to the 3D station (Reconstruction, Storage) Two use cases of how the protocols can be selected:

652 - A: user selects the protocol elements manually

654 - B: user selects one acquisition protocol, the storage is automatically triggered. Then in workstation, the reconstruction and further storage are triggered automatically based on the references from the image header

656 **XXXX.4 QA and Best Practice Defined Procedure Protocol**

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

660 TO DO: add example: Use case of taking a generic protocol (e.g. AAPM) and transforming it into a specific device that does not support all the parameters defined by AAPM. And with parameters not defined yet in DICOM Part 3 (e.g. new features on the vendor model). Perform acquisition, record the Performed Protocol parameters, do QA on the images.

662

664