ACC-ACR-NEMA

Digital Imaging and Communications in Medicine (DICOM)

Supplement 4
X-Ray Angiographic Image Objects and Media Storage

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Foreword

ACC (the American College of Cardiology), NEMA (the National Electrical Manufacturers Association) and the ACR (the American College of Radiology) formed a joint ad-hoc Committee to further expand the Standard for Digital Imaging and Communications in Medicine initially developed by ACR and NEMA. The corresponding Supplements to the DICOM Standard were developed according to the NEMA Procedures

This Supplement to the Standard is developed in liaison with other Standard Organizations including CEN TC251 in Europe and JIRA in Japan, with review also by other organizations member of the ANSI HISPP in the USA which includes IEEE, HL7 and X12.

The DICOM standard is structured as a multi-part document using the guidelines established in the following document:

- ISO/IEC Directives, 1989 Part 3 - Drafting and Presentation of International Standards.

This document is a Supplement to the DICOM Standard. It is an extension to Part 3, 4 and 6 of the published DICOM Standard which consists of the following parts:

Part 1	—	Introduction and Overview
Part 2	—	Conformance
Part 3	—	Information Object Definitions
Part 4	—	Service Class Specifications
Part 5	—	Data Structures and Encoding
Part 6	—	Data Dictionary
Part 7	—	Message Exchange
Part 8	—	Network Communication Support for Message Exchange
Part 9	—	Point-to-Point Communication Support for Message Exchange
Part 10		Media Storage and File Format
Part 13		Print Management - Point-to-point Communication Support

These Parts are independent but related documents.

This Supplement includes the definition of the X-Ray Angiographic Image Objects and of the corresponding Media and Network Storage Service Class. This Supplement may be used in conjunction with Supplement 3 which specifies the CD-R Media Format and Physical Media, to provide the ability to interchange Cardiac Images.

This XA IOD share a significant amount of common information with the XRF IOD. The differences between the two IODs are that the XRF Image IOD includes a tomography module; and the two IODs utilize different methods to specify positioner angles. The XRF Image IOD contains a single column angulation Data Element which uses an equipment based coordinate system, while XA Image IOD c-arm positioner angles are specified in a patient based coordinate system. RF applications which support a patient-based coordinate system with cranial/caudal, LAO/RAO angles may utilize the XA IOD.

The XA IOD is also applicable to clinical areas other than angiography (e.g. Interventional Procedures, Myelography, Biopsy/Localization, and Neurology).

Scope and Field of Application

This Supplement to the DICOM Standard specifies a DICOM image Information Object for X-Ray Angiography. It specifies the semantic content of X-Ray XA Images. It is commonly abbreviated the XA IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges.

The scope of the XA IOD is to address images produced on acquisition equipment equipped with an X-Ray source and an image Receptor positioned by what is general called a c-arm For clinical areas other than Angiography which are using a c-arm to position the X-Ray source and image receptor (e.g. Interventional Procedures and Myelography and Biopsy/Localization), the X-Ray Angiography Image Object should be also used. Although the IOD is optimized for c-arm systems, it may also be used by other systems which support a similar coordinate system.

Since this document proposes changes to existing Parts of DICOM the reader should have a working understanding of the Standard.

This proposed Supplement includes a number of Addenda to existing Parts of DICOM:

1. Part 3 Addenda (Extension to the body, Annex A, C and D)
2. Part 4 Addenda (Extension to Annex B)
3. Part 6 Addenda (Extension to Section 6 and Annex A)
4. Part 11 Addenda (Addition of Annex A)

ACC-ACR-NEMA

Digital Imaging and Communications in Medicine (DICOM)

Part 3 Addendum
X-Ray Angiographic Image Information Object Definition

Item #1
Add the following definition to the list of Section 3

3.8 DICOM Information Object Definitions

3.8.10 Cine Run: A set of temporally related frames acquired at constant or variable frame rates. This term incorporates the general class of serialography.

Note: A Cine Run is typically encoded as a multi-frame image.

Item #2
Add to Section 5

5.3 Triplet Encoding of Structured Data

Structured data entry using standardized coding schemes is a fundamental requirement of a computer-based patient record. Many DICOM modules utilize sequences to allow structured data entry to convey coded entries of many types (e.g. Primary Anatomic Structure Sequence (0008,2228), Patient's Insurance Plan Code Sequence (0010,0050), Interventional Drug Sequence (0018,0029)). These sequences utilize triplets to define the coding scheme to be used (Coding Scheme Designator (0008,0102)), a code value from that scheme (Code Value (0008,0100)), and the textual translation of that code value (Code Meaning (0008,0104)).

Note: Triplet encoding of such coded entries is compatible with the ANSI HISPP Common Data Types (see the "ANSI HISPP MSDS Common Data Types" document).

The Code Value (0008,0100) is a computer readable and computer searchable identifier that is unambiguous within the Coding Scheme.

The Coding Scheme Designator (0008,0102) uniquely identifies the table (Coding Scheme) where the Code Value (0008,0100) is linked to its Code Meaning (0008,0104). Common coding schemes include CPT, ICD-9, SNOMED, etc. Coding Scheme Designators available for use by DICOM implementations are described in Annex D.

Note: Until an internationally-recognized Coding Scheme Designator registration authority is available (such as the authority proposed in "CEN/TC251/PT005 FFV Document. Health Care Informatics Interchange - Registration of Coding Schemes"), the tables of provisional Coding Scheme Designators found in the "ANSI HISPP Common Data Types" document (duplicated in Annex D of PS 3.3) may be used.

The Code Meaning (0008,0104) is human readable text which is provided for the convenience of the readers of the Information Object (i.e., the reader would not need to refer to the Coding Scheme to find the interpretation of the Code Value (0008,0100)).

Note: Data Elements having 1) a VR of "SQ" (Sequence of Items) and 2) containing triplet-encoded items (utilizing Coding Scheme Designator, Code Value, Code Meaning) within one or more component sequence(s) may conceivably require additional encoding and/or interpretation rules (semantic mapping for most advantageous use with a particular coding scheme in a given context). The SNOMED DICOM MICROGLOSSARY (SDM), referenced in this Standard as coding Scheme Designator 99SDM, links sets of appropriate terms from SNOMED International (College of American Pathologists, Northfield, IL) to DICOM Data Elements. The SDM lists the appropriate SNOMED terms and the semantic dependencies for DICOM triplet-encoded sequence Data Elements according to SOP Class UID and real-world functional context. The SDM maps DICOM concepts to the Unified Medical Language System (UMLS) of the United States National Library of Medicine. Each SDM record contains a UMLS unique concept identifier (CUI) that links a DICOM concept to the UMLS knowledge sources and enables information retrieval from bibliographic resources via the NLM Medical Subject Headings (MeSH). The SDM also provides a shared mapping of Data Elements among message standards.

If the Coding Scheme Designator (0008,0102) of a particular triplet encoded Data Element is 99SDM, then the Code Value (0008,0100) for that Data Element will be the Source UID value from a SNOMED DICOM Microglossary record. This record will have a Data Element UID which matches the Data Element Tag of the DICOM triplet-encoded sequence and Class UID consistent with the DICOM SOP Class UID of the Data Set being encoded. The Semantic Type of the SDM record will match the Semantic Type called for by the DICOM description of that attribute. Unless otherwise stated in this Standard, the SDM record may have any Context value.

Item #3
Add in Table A.1-1 - all modifications to existing table is in BOLD font

Table A.1.4 - Composite Information Object Modules Overview

IODs Modules	CR	CT	MR	NM	US	US-mf	Sec. Capt	St. Over-lay	St. Curve	Study Descr.	St. Mod LUT	St. VOI LUT	XA	XA Bi-plane
Patient	M	M	M	M	M	M	M	M	M		M	M	**M**	**M**
Patient Summary										M				
General Study	M	M	M	M	M	M	M	M	M		M	M	**M**	**M**
Patient study	U	U	U	U	U	U	U	U	U		U	U	**U**	**U**
Study Content										M				
General Series	M	M	M	M	M	M	M	M	M		M	M	**M**	**M**
CR Series	M													
NM Series				M										
Frame Of		M	M	U	U	U								

Reference														
US Frame of Ref.					C	C								
General Equipment	M	M	M	M	M	M	U	M	M		M	M	**M**	**M**
NM Equipment				U										
SC Equipment							M							
General Image	M	M	M	M*	M*	M	M						**M**	**M**
Image Plane		M	M	U*										
Image Pixel	M	M	M	M*	M*	M	M						**M**	**M**
Contrast/Bolus	C	C	C		C*	C							**C**	**C**
Cine				C		C							**C**	**C**
Multi-frame				C		M							**C**	**C**
Frame Pointers													**U**	**U**
Mask													**C**	**C**
Display Shutter													**U**	**U**
Device													**U**	**U**
Therapy													**U**	**U**
CR Image	M													
CT Image		M												
MR Image			M											
NM Image				M*										
NM SPECT				C										
NM Multi-Gated				C										
US Region Calibration					U*	U								
US Image					M*	M								
SC Image							M							
X-Ray Image													**M**	**M**
X-Ray Acquisition													**M**	**M**
X-Ray Collimator													**U**	**U**
X-Ray Table													**C**	**C**
XRF Positioner														
XRF Tomo Acquisition														
XA Positioner													**M**	**M**
Bi-Plane Sequence														**M**
Bi-Plane Image														**M**
Overlay Identification				M*				M						
Overlay Plane	U	U	U	M*	U*		U	M					**U**	**U**
Multi-frame Overlay				U									**C**	**C**
Bi-Plane Overlay														**C**
Curve Identification				M*	M*	M*			M					
Curve				M*	M*	M*			M				**U**	**U**
Audio					U	U								
Modality LUT	U						U				M		**C***	**C***
VOI LUT	U	U	U	U*	U*	U	U					M	**U**	**U**
LUT Identification											M	M		
SOP Common	M	M	M	M*	M*	M*	M	M	M	M	M	M	**M**	**M**

* The notation next to M and U indicates a special condition for these modules. Refer to the corresponding Information Object Definitions in this Annex for details.

Item #4
Add the following Sections after Section A.13:

A.14 X-Ray Angiographic Image Information Object Definition

A.14.1 XA Image IOD Description

This section defines the Information Object for single plane X-Ray Angiographic Imaging which includes those data elements and information objects necessary for the interchange of digital X-Ray Angiographic data. This includes images of the heart and all blood vessels.

The XA IOD share a significant amount of common information with the XRF IOD. The differences between the two IODs are that the XRF Image IOD includes a tomography module; and the two IODs utilize different methods to specify positioner angles. The XRF Image IOD contains a single column angulation Data Element which uses an equipment based coordinate system, while XA Image IOD c-arm positioner angles are specified in a patient based coordinate system. RF applications which support a patient-based coordinate system with cranial/caudal, LAO/RAO angles may utilize the XA IOD.

The XA IOD is also applicable to clinical areas other than angiography (e.g. Interventional Procedures, Myelography, Biopsy/Localization, and Neurology).

Notes: 1) For the purpose of X-Ray Angiography (XA), this IOD can be used to encode a single frame image, or a Cine Run encoded in a single multi-frame image.

2) A typical study might include all the images generated between the time a patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single study (e.g., pre-intervention CA, left ventriculography, and post-intervention CA), a series may be defined as comprising a set of images (single or Multi-Frame) associated with one such process within a study.

3) This IOD can be used to encode a single plane acquisition, or one plane of a biplane acquisition.

A.14.2 XA Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 of this part depicts those components of the DICOM Application Information Model which directly reference the X-Ray Angiographic Image IOD, with exception of the Frame of Reference and Modality LUT entities which are not used. Additionally, "Image" in Figure A.1.2 may represent a Single Frame or a Multi-Frame image. A frame denotes a two-dimensional organization of pixels recorded as a single exposure.

A.14.3 XA Image IOD Module Table

Table A.14.3-1 - X-Ray Angiographic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C-Required if contrast media was used in this Image
	Cine	C.7.6.5	C - Required if pixel data is Multi-Frame Cine data
	Multi-Frame	C.7.6.6	C - Required if pixel data is Multi-Frame Cine data
	Frame Pointers	C.7.6.9	U
	Mask	C.7.6.10	C-Required if the Image may be subtracted
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Therapy	C.7.6.13	U
	X-Ray Image	C.8.7.1	M
	X-Ray Acquisition	C.8.7.2	M
	X-Ray Collimator	C.8.7.3	U
	X-Ray Table	C.8.7.4	C - Required if Image is created with table motion
	XA Positioner	C.8.7.5	M
	Overlay Plane	C.9.2	U
	Multi-Frame Overlay	C.9.3	C-Required if Overlay data contains multiple frames.
	Curve	C.10.2	U (See 8.7.1.1.9)
	Modality LUT	C.11.1	C-Required if Pixel Intensity Relationship (0028,1040) is LOG U-Optional if Pixel Intensity Relationship (0028,1040) is DISP
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.15 X-Ray Angiographic Bi-Plane Image Information Object Definition

A.15.1 XA Bi-Plane Image IOD Description

This section defines the Information Object for bi-plane X-Ray Angiographic Imaging which includes those data elements and information objects necessary for the interchange of digital X-Ray Angiographic data. This includes images of the heart and all blood vessels acquired simultaneously in two (nominally orthogonal) planes.

NOTES: 1) For the purpose of X-Ray Angiography (XA), this IOD can be used to encode a single bi-plane frame image, or a Cine Run encoded in a single bi-plane multi-frame image.

2) A typical study might include all the images generated between the time a patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single study (e.g., pre-intervention CA, left ventriculography, and post-intervention CA), a series may be defined as comprising a set of images (single or Multi-Frame) associated with one such process within a study.

A.15.2 XA Bi-Plane Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 of this part depicts those components of the DICOM Application Information Model which directly reference the X-Ray Angiographic Bi-plane Image IOD, with exception of the Frame of Reference and Modality LUT entities which are not used. Additionally, "Image" in Figure A.1.2 may represent a single Bi-plane Frame or a Bi-plane Multi-Frame image. A bi-plane frame denotes two, two-dimensional organizations of pixels recorded at a single time.

A.15.3 X-Ray Angiographic Bi-Plane Image IOD Module Table

Table A.15.3-1 - X-Ray Angiography Bi-Plane Image IOD

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C-Required if contrast media was used in this Image
	Cine	C.7.6.5	C - Required if pixel data is Multi-Frame Cine date
	Multi-Frame	C.7.6.6	C - Required if pixel data is Multi-Frame Cine date
	Bi-Plane Sequence	C.7.6.7	M
	> Bi-Plane Image	C.7.6.8	M
	> Frame Pointers	C.7.6.9	U
	> Mask	C.7.6.10	C-Required if the Image may be subtracted
	> Display Shutter	C.7.6.11	U
	> X-Ray Acquisition	C.8.7.2	M
	> X-Ray Collimator	C.8.7.3	U
	> XA Positioner	C.8.7.5	M
	> VOI LUT	C.11.2	U
	Device	C.7.6.12	U
	Therapy	C.7.6.13	U
	X-Ray Image	C.8.7.1	M
	X-Ray Table	C.8.7.4	C - Required if Image is created with to table motion
	Overlay Plane	C.9.2	U
	Multi-Frame Overlay	C.9.3	C-Required if Overlay data contains multiple frames.
	Bi-Plane Overlay	C.9.4	C-Required if Overlay data is present
	Curve	C.10.2	U (See 8.7.1.1.9)

	Modality LUT	C.11.1	C-Required if Pixel Intensity Relationship (0028,1040) is LOG U-Optional if Pixel Intensity Relationship (0028,1040) is DISP
	SOP Common	C.12.1	M

Item #5
Replace Section C.7.2.1 with the following:
NOTE: All modifications to existing tables are listed with a BOLD font

C.7.2.1 General Study Module

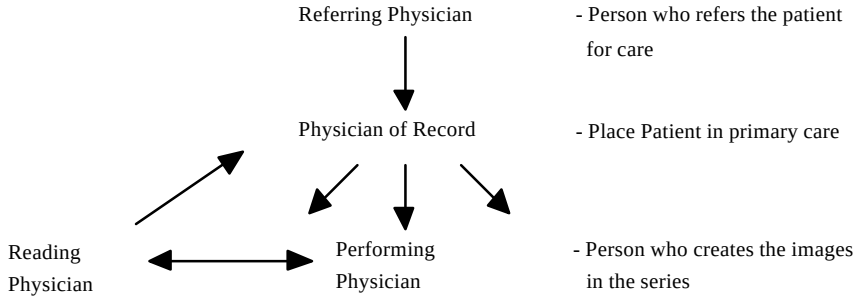
Table C.7-2 specifies the Attributes which describe and identify the Study performed upon the Patient.

Table C.7.2.1-1 -- General Study Module Attributes

Attribute Name	Tag	Type	Attribute Description
Study Instance UID	(0020,000D)	1	Unique identifier for the Study.
Study Date	(0008,0020)	2	Date the Study started.
Study Time	(0008,0030)	2	Time the Study started.
Referring Physician's Name	(0008,0090)	2	Patient's referring physician
Study ID	(0020,0010)	2	User or equipment generated Study identifier.
Accession Number	(0008,0050)	2	An RIS generated number which identifies the order for the Study.
Study Description	(0008,1030)	3	Institution-generated description or classification of the Study (component) performed.
Physician(s) of Record	**(0008,1048)**	**3**	**Physician(s) who are responsible for overall patient care at time of Study (see section C.7.3.1 for Performing Physician)**
Name of Physician (s) Reading Study	(0008,1060)	3	Physician (s) reading the Study.
Referenced Study Sequence	(0008,1110)	3	A sequence which provides reference to a Study SOP Class/Instance pair. Only a single reference is allowed. Encoded as sequence of items:

			(0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Study Sequence(0008,1110) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Sequence(0008,1110) is sent.

Note: The model used for application of attributes related to different functions of Physicians involved in the care is as follows:



There can be an overlap of functions provided by any given physician. In this case the field entries would convey the same physician name under different roles.

Item #6
Replace Section C.7.3.1 with the following:
NOTE: All modifications to existing tables are listed with a BOLD font

C.7.3.1 General Series Module

Table C.7.3.1 specifies the Attributes which identify and describe general information about the Series within a Study.

Table C.7.3.1-1 -- General Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. See C.7.3.1.1.1 for Defined Terms.
Series Instance UID	(0020,000E)	1	Unique identifier of the Series.
Series Number	(0020,0011)	2	A number that identifies this Series.
Laterality	(0020,0060)	2C	Laterality of (paired) body part examined. Required if the body part examined is a paired structure. Enumerated Values: R = right, L = left
Series Date	(0008,0021)	3	Date the Series started.
Series Time	(0008,0031)	3	Time the Series started.
Performing Physicians' Name	(0008,1050)	3	Name of the physicians administering the Series.
Protocol Name	(0018,1030)	3	User-defined description of the conditions under which the Series was performed.
Series Description	(0008,103E)	3	User provided description of the Series
Operators' Name	(0008,1070)	3	Technologist (s) supporting the Series.
Referenced Study Component Sequence	(0008,1111)	3	Uniquely identifies the Study Component SOP Instances to which the Series is related.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Study Component Sequence(0008,1111) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Component Sequence(0008,1111) is sent.
Body Part Examined	(0018,0015)	3	Text description of the part of the body examined. Defined Terms: SKULL, CSPINE, TSPINE, LSPINE, SSPINE, COCCYX, CHEST, CLAVICLE, BREAST, ABDOMEN, PELVIS, HIP, SHOULDER, ELBOW, KNEE, ANKLE, HAND, FOOT, EXTREMITY, **HEAD, HEART,**

			NECK, LEG, ARM Note: Some IODs support the Anatomic Region Sequence (0008,2218), which can provide a more comprehensive mechanism for specifying the body part being examined.
Patient Position	(0018,5100)	2C	Patient position descriptor relative to the equipment. Required for CT and MR images. See C.7.3.1.1.2. for Defined Terms and further explanation.
Smallest Pixel Value in Series	(0028,0108)	3	The minimum value of all images in this Series.
Largest Pixel Value in Series	(0028,0109)	3	The maximum value of all images in this Series.

C.7.3.1.1 General Series Attribute Descriptions

C.7.3.1.1.1 Modality

Item #7
Add to Section C.7.3.1.1.1 the following Defined Terms:

XA = X-Ray Angiography

RF = RadioFluoroscopy

Item #8
Change in Section C.7.3.1.1.1 the following Defined Terms:

Retired Defined Terms for the Modality (0008,0060) are:

DS = Digital Subtraction Angiography (retired)

CF = Cinefluorography (retired)

DF = Digital fluoroscopy (retired)

VF = Videofluorography (retired)

Notes: 1) The XA modality incorporates the retired modality DS.

2) The RF modality incorporates the retired modalities CF, DF, VF.

3) The modality listed in the Modality Data Element (0008,0060) may not match the name of the IOD in which it appears. For example, a SOP instance from the XA IOD may list the RF modality when an RF implementation produces an XA object.

Item #9
Add the following to the General Image Module.

C.7.6.1 General Image Module

Addition to Table C.7.61— General Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression	(0028,2110)	3	Specifies whether an Image has undergone lossy compression. Enumerated Values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression. See C.7.6.1.1.5

C.7.6.1.1.5 Lossy Image Compression

The Attribute Lossy Image Compression (0028,2110) conveys that the Image has undergone lossy compression. It provides a means to record that the Image has been compressed (at a point in its lifetime) with a lossy algorithm and changes have been introduced into the pixel data. Once the value has been set to "01", it shall not be reset.

Note: If an image is compressed with a lossy algorithm, the attribute Lossy Image Compression (0028,2110) is set to "01". Subsequently, if the image is decompressed and transferred in uncompressed format, this attribute value remains "01".

The value of the Lossy Image Compression (0028,2110) Attribute in SOP Instances containing multiple frames in which one or more of the frames have undergone lossy compression shall be "01".

Note: It is recommended that the applicable frames be noted in the Attribute Derivation Description (0008,2111).

If Lossy Image Compression (0028,2110) is set to "01", Value 1 of the Attribute Image Type (0008,0008) shall be set to DERIVED, and the Image shall receive a new SOP Instance UID.

Notes: 1. It is recommended that the approximate compression ratio be provided in the Attribute Derivation Description (0008,2111). Furthermore, it is recommended that Derivation Description (0008,2111) be used to indicate when pixel data changes might affect professional interpretation. (see C.7.6.1.1.3).

2. The attribute Lossy Image Compression (0028,2110) is defined as Type 3 for backward compatibility with existing IODs. It is expected to be required (i.e., defined as Type 1C) for new Image IODs and for existing IODs which undergo a major revision (e.g. a new IOD is specified).

Item #10
Add in Section C.7.6.4 the following new text shown in BOLD font:

C.7.6.4 Contrast/Bolus

Table C.7.6.4-1 specifies the attributes that describe the contrast /bolus used in the acquisition of the Image.

Table C.7.6.4-1 - Contrast/Bolus Module Attributes

Attribute Name	Tag	Type	Attribute Description
Contrast/Bolus Agent	(0018,0010)	2	Contrast or bolus agent
Contrast/Bolus Agent Sequence	**(0018,0012)**	**3**	**Sequence that identifies the contrast agent.**
>Code Value	**(0008,0100)**	**1C**	**The code value (defined by the coding scheme) that represents the contrast agent. Required if Contrast/Bolus Agent Sequence (0018,0012) is sent. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Contrast Agent when the Coding Scheme Designator (0008,0102) is 99SDM**
>Coding Scheme Designator	**(0008,0102)**	**1C**	**The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Contrast/Bolus Agent Sequence (0018,0012) is sent. Defined Terms: 99SDM**
>Code Meaning	**(0008,0104)**	**3**	**The contrast agent that is represented by the Code Value (0008,0100).**
Contrast/Bolus Route	(0018,1040)	3	Administration route of contrast agent
Contrast/Bolus Administration Route Sequence	**(0018, 0014)**	**3**	**Sequence that identifies the route of administration of contrast agent.**
>Code Value	**(0008,0100)**	**1C**	**The code value (defined by the coding scheme) that represents the contrast agent administration**

			route. Required if Contrast/Bolus Administration Route Sequence (0018,0014) is sent. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Drug Administration Route when the Coding Scheme Designator (0008,0102) is 99SDM.
>Coding Scheme Designator	**(0008,0102)**	**1C**	**The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Contrast/Bolus Administration Route Sequence (0018,0014) is sent. Defined Terms: 99SDM**
>Code Meaning	**(0008,0104)**	**3**	**The contrast agent administration route that is represented by the Code Value (0008,0100).**
>Additional Drug Sequence	**(0018,002A)**	**3**	**Sequence that identifies any additional drug that is administered with the contrast agent bolus.**
>>Code Value	**(0008,0100)**	**1C**	**The code value (defined by the coding scheme) that represents the drug. Required if Additional Drug Sequence (0018,002A) is sent. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Interventional Drug when the Coding Scheme Designator (0008,0102) is 99SDM**
>>Coding Scheme Designator	**(0008,0102)**	**1C**	**The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Additional Drug Sequence (0018,002A) is sent. Defined Terms: 99SDM**
>>Code Meaning	**(0008,0104)**	**3**	**The drug that is represented by the Code Value (0008,0100).**
Contrast/Bolus Volume	(0018,1041)	3	Volume **injected in milliliters of**

			diluted contrast agent
Contrast/Bolus Start Time	(0018,1042)	3	Time of start of injection
Contrast/Bolus Stop Time	(0018,1043)	3	Time of end of contrast injection
Contrast/Bolus Total Dose	(0018,1044)	3	Total amount **in milliliters of the undiluted contrast agent**
Contrast Flow Rate(s)	**(0018,1046)**	**3**	**Rate(s) of injection(s) in milliliters/sec**
Contrast Flow Duration(s)	**(0018,1047)**	**3**	**Duration(s) of injection(s) in seconds. Each Contrast Flow Duration value shall correspond to a value of Contrast Flow Rate (0018,1046).**
Contrast/Bolus Ingredient	**(0018,1048)**	**3**	**Active ingredient of agent. Defined Terms:** **IODINE** **GADOLINIUM** **CARBON DIOXIDE** **BARIUM**
Contrast/Bolus Ingredient Concentration	**(0018,1049)**	**3**	**Milligrams of active ingredient per milliliter of (diluted) agent**

Notes:

1. Flow duration is an alternate method of specifying stop time

2. Flow rate allows for stepped injections by being capable of multiple values (1,N) instances.

3. For a 100 ml injection of 76% Diatrizoate and meglumine/sodium, diluted 1:1,
   the Contrast/Bolus Agent would be "76% Diatrizoate" as text
   the Contrast/Bolus Volume would be 100 ml,
   the Contrast/Bolus Total Dose would be 50 ml,
   the Contrast/Bolus Ingredient would be "IODINE",
   the Contrast/Bolus Ingredient Concentration would be 370 mg/ml

Item #11
Change Section C.7.6.5.1.2 to correct the definition of the Frame Time Vector:

C.7.6.5.1.2 Frame Time Vector

Frame Time Vector (0018,1065) is an array which contains the time increments (in milliseconds) between the nth frame and the previous frame for a Multi-frame image. The first frame always has a time increment of 0. If the Frame Increment Pointer points to this Attribute, the Frame Time Vector shall be used in the following manner to calculate 'relative time' *T(n)* for frame *n*:

$$\sum \Delta$$

where Δ is the ith Frame Time Vector component.

Item #12
Add a Bi-Plane Sequence Module

C.7.6.7 Bi-Plane Sequence Module

This section describes the Attributes associated with the Image when it has the property of two planes of acquisition. This module is used to introduce a sequence of exactly two items, each item containing attributes of one image plane.

Table C.7.6.7-1— Bi-Plane Sequence Module Attributes

Attribute Name	Tag	Type	Attribute Description
Planes	(0028,0012)	1	Number of planes Enumerated value = 2
Bi-Plane Acquisition Sequence	(0028,5000)	1	Introduces sequence of items describing acquisition in each plane.

Item #13
Add a Bi-Plane Image Module

C.7.6.8 Bi-Plane Image Module

This section describes the Attributes uniquely associated with each plane of a bi-plane image.

NOTE: This Module is intended to be part of a sequence item associated with a single plane in a bi-plane Image Information Entity.

Table C.7.6.8-1— Bi-Plane Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Smallest Image Pixel Value in Plane	(0028,0110)	3	The minimum actual pixel value encountered in the image plane.
Largest Image Pixel Value in Plane	(0028,0111)	3	The maximum actual pixel value encountered in the image plane.

C.7.6.8.1 Bi-Plane Image Attribute Descriptions

The Smallest and Largest Image Pixel Values in Plane can be compared to the Smallest and Largest Image Pixel Values (tags (0028,0106) and (0028,0107) in the Image Pixel Module), which apply to the entire bi-plane image, and the Smallest and Largest Image Pixel Values in Series (tags (0028,0108) and (0028,0109) in the General Series Module).

Item #14
Add new Section C.7.6.9 :

C.7.6.9 Frame Pointers Module

Table C.7.6.9 specifies the attributes of a Frame Pointer Module.

Table C.7.6.9-1 -- Frame Pointers Module Attributes

Attribute Name	Tag	Type	Attribute Description
Representative Frame Number	(0028,6010)	3	The frame number selected for use as a pictorial representation (e.g. icon) of the Multi-frame Image
Frame Numbers Of Interest (FOI)	(0028,6020)	3	Frame number(s) selected as frames of interest.
Frame Of Interest Description	(0028,6022)	3	Description of each one of the Frame(s) of Interest selected in (0028,6020). If multiple Frames of Interest are selected and this Attribute is used, it shall contain the same number of values as are in Frame Numbers of Interest (0028,6020).

Notes: 1) Frame numbers begin at 1.

2) Frame of Interest Description is intended to indicate such frames as Systolic, Diastolic, Stenotic Artery.

Item #15
Add new Section C.7.6.10:

2

C.7.6.10 Mask Module

4 Table C.7.6.10-1 specifies the Attributes that describe mask operations for a Multi-frame image.

Table C.7.6.10-1 -- Mask Module Attributes

Attribute Name	Tag	Type	Attribute Description
Mask Subtraction Sequence	(0028,6100)	1	Defines a sequence which describe mask subtraction operations for a Multi-frame Image.
>Mask Operation	(0028,6101)	1	Defined Term identifying the type of mask operation to be performed. See C.7.6.10.1 for further explanation.
>Applicable Frame Range	(0028,6102)	3	Each pair of numbers in this multi-valued attribute specify a beginning and ending frame number inclusive of a range where this particular mask operation is valid. Discontinuous ranges are represented by multiple pairs of numbers. Frames in a Multi-frame Images are specified by sequentially increasing number values beginning with 1. If this Attribute is missing in this particular sequence item, then the mask operation is applicable throughout the entire Multi-frame image, subject to certain limits as described in C.7.6.10.1.1.
>Mask Frame Numbers	(0028,6110)	1C	Specifies the frame numbers of the pixel data used to generate this mask. Frame in a Multi-frame image are specified by sequentially increasing number values beginning with 1. Required if the Mask Operation (0028,6101) is AVG_SUB.
>Contrast Frame Averaging	(0028,6112)	3	Specifies the number of contrast frames to average together before

			performing the mask operation. If the Attribute is missing, no averaging is performed.
>Mask Sub-pixel Shift	(0028,6114)	3	A pair of floating point numbers specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from the contrast frame. See Section C.7.6.10.1.2.
>TID Offset	(0028,6120)	2C	Specifies the offset to be subtracted from the current frame number in order to locate the mask frame in TID mode. If omitted, TID Offset defaults to 1. Used when Mask Operation (0028,6101) is TID.
>Mask Operations Explanations	(0028,6190)	3	Free form explanation of this particular mask operation.
Recommended Viewing Mode	(0028,1090)	2	Specifies the recommended viewing protocol(s). Defined terms: SUB = for subtraction with mask images; NAT = native viewing of image as sent. Note: If an implementation does not recognize the defined term for Recommended Viewing Mode (0028,1090) , reverting to native display mode is recommended.

Note: Frame numbers begin at 1.

C.7.6.10.1 Mask Subtraction Attribute Descriptions

C.7.6.10.1.1 Mask Operation

Mask Operation (0028,6100) specifies a type of mask operation to be performed. The Defined Terms identifying the mask operation to be performed are as follows:

NONE (No Subtraction) No mask subtraction operation is specified;

AVG_SUB (Average Subtraction) The frames specified by the Mask Frame Numbers (0028,6110) are averaged together, shifted by the amount specified in the Mask Sub-pixel Shift (0028,6114), then subtracted from the contrast frames in the range specified in the Applicable Frame Range (0028,6102) . Contrast Frame (0028,6112) number of frames starting with the current frame are averaged together before the subtraction. If the Applicable Frame Range is not present in this sequence item, the Applicable Frame Range is assumed to end at the last frame number of the image minus Contrast Frame Averaging (0028,6112) plus one;

TID (Time Interval Differencing) The mask for each frame within the Applicable Frame Range (0028,6102) is selected by subtracting TID Offset (0028,6120) from the respective frame number. If the Applicable Frame Range is not present in this sequence item, the Applicable Frame Range is assumed to be a range where TID offset subtracted from any frame number with the range results in a valid frame number within the Multi-frame image.

C.7.6.10.1.2 Mask Sub-pixel Shift

A pair of floating point numbers specifying the fractional pixel shift specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from the contrast frame. The row offset results in a shift of the pixels along the column axis. The column offset results in a shift of the pixels along the row axis. A positive row offset is a shift towards the pixels of the lower row of the pixel plane. A positive column offset is a shift towards the pixels of the left hand side column of the pixel plane.

C.7.11 Display Shutter Module

The Display shutter is a geometric mask which may be applied on the image for presentation purposes in order to neutralize the display of any of the pixels located outside of the shutter shape. Geometry of the collimator is specified with respect to a row and column coordinate system where the origin is the upper left hand pixel. This origin is specified by the values 1,1 for row/column. A row coordinate represent a number of raw spacing (vertical) and a column coordinate represents a column spacing (horizontal). Up to three different shutter shapes may be used and superimposed.

The manner in which the display area is neutralized (black-out, gray, or other means) is beyond the scope of this Standard.

Table C.7.6.11-1 -- Display Shutter Module

Attribute Name	Tag	Type	Attribute Description
Shutter Shape	(0018,1600)	1	Shape(s) of the shutter defined for display. Enumerated Values are: RECTANGULAR CIRCULAR POLYGONAL This multi-valued Attribute shall contain at most one of each Enumerated Value.
Shutter Left Vertical Edge	(0018,1602)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the left edge of the rectangular shutter with respect to pixels in the image given as column.
Shutter Right Vertical Edge	(0018,1604)	1C	Required if Shutter Shape (0018,1500) is RECTANGULAR. Location of the right edge of the rectangular shutter with respect to pixels in the image given as column.
Shutter Upper Horizontal Edge	(0018,1606)	1C	Required if Shutter Shape (0018,1500) is RECTANGULAR. Location of the upper edge of the rectangular shutter with respect to pixels in the image given as row.
Shutter Lower Horizontal Edge	(0018,1608)	1C	Required if Shutter Shape (0018,1500) is RECTANGULAR. Location of the lower edge of the rectangular shutter with respect to pixels in the image given as row.
Center of Circular Shutter	(0018,1610)	1C	Required if Shutter Shape (0018,1500) is CIRCULAR. Location of the center of the circular shutter with respect to pixels in the image given as row and column.
Radius of Circular Shutter	(0018,1612)	1C	Required if Shutter Shape (0018,1500) is CIRCULAR. Radius of the circular shutter with respect to pixels in the image given as a number of pixels along the row direction.
Vertices of the Polygonal Shutter	(0018,1620)	1C	Required if Shutter Shape (0018,1600) is POLYGONAL. Multiple Values where the first set of two values are:

			row of the origin vertex column of the origin vertex Two or more pairs of values follow and are the row and column coordinates of the other vertices of the polygon shutter. Polygon shutters are implicitly closed from the last vertex to the origin vertex are shall be non-intersecting polygons.

C.7.6.12 Device

The table in this section describes the Attributes of devices (e.g., catheters, markers, baskets) which are associated with a study and/or image.

Table C.7.6.12-1 -- Device Module Attributes

Attribute Name	Tag	Type	Attribute Description
Device Sequence	(0050,0010)	3	Introduces sequence of items describing devices used which may be visible in the image
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the device. Required if Device Sequence (0050,0010) is present. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Interventional Device when the Coding Scheme Designator (0008,0102) is 99SDM. ~~Appropriate values can be found in the SNOMED/DICOM Microglossary Angiographic Device list.~~
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). ~~See Annex X for an interim list.~~ Required if Device Sequence (0050,0010) is present. Defined Terms: 99SDM
>Code Meaning	(0008,0104)	3	The device that is represented by the Code Value (0008,0100). May be present if Device Sequence (0050,0010) is present.
>Device Length	(0050,0014)	3	Length in mm of device. Required as per Table in section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.
>Device Diameter	(0050,0016)	3	Unit diameter of device. Required as per Table in section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.

>Device Diameter units	(0050,0017)	2C	Required if Device Diameter (0050,0016) is present. Defined terms: FR = French GA = Gauge IN = Inch MM = Millimeter May be present only if Device Sequence (0050,0010) is present.
>Device Volume	(0050,0018)	3	Volume of device in ml. Required as per Table in section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.
>Inter-Marker Distance	(0050,0019)	3	Distance in mm between markers on calibrated device. Required as per Table in section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.
>Device Description	(0050,0020)	3	Further description in free form text describing the device. May be present only if Device Sequence (0050,0010) is present.

Note: The value 99SDM from Annex D may be used for the Coding Scheme Designator pointing to ~~the~~ SNOMED/DICOM Microglossary terms of semantic type Interventional Device~~Angiographic Device list~~. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.7.6.12.1 Device Attribute Descriptions

C.7.6.12.1.1 Device Type and Size

Depending on the type of device specified by the Code Value (0008,0100) in an item of the Device Sequence (0050,0010), various device size attributes (e.g., Device Length (0050,0014), Device Diameter (0050,0016), Device Volume (0050,0018), Inter Marker Distance (0050,0019)) may be required to fully characterize the device.

Note The attributes required to fully characterize the devices in the SNOMED/DICOM Microglossary Angiographic Device list are specified in that list.

C.7.6.13 Therapy

The table in this section describes the Attributes of therapies (e.g. interventions during an angiographic procedure) which are associated with a study and/or image.

Table C.7.6.13-1 -- Therapy Module Attributes

Attribute Name	Tag	Type	Attribute Description
Interventional Therapy Sequence	(0018,0036)	3	Introduces sequence of items describing interventional therapies
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the interventional therapy. Required if Interventional Therapy Sequence (018,0036) is present. ~~Appropriate v~~Values shall be taken from ~~can be found in the~~ SNOMED/DICOM Microglossary terms of semantic type Interventional Procedure ~~Angiographic Therapy list~~ when the Coding Scheme Designator (0008,0102) is 99SDM.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Interventional Therapy Sequence (0018,0036) is present. Defined Terms: 99SDM
>Code Meaning	(0008,0104)	3	The interventional therapy that is represented by the Code Value (0008,0100). May be present if Interventional Therapy Sequence (0018,0036) is present.
>Interventional Status	(0018,0038)	2	Temporal relation to therapeutic intervention Specialized as Enumerated Values: PRE INTERMEDIATE POST NONE Required if Interventional Therapy Sequence (0018,0036) is present.
>Interventional Drug Sequence	(0018,0029)	3	Sequence that identifies the interventional drug. May be present if Interventional Therapy Sequence

			(0018,0036) is present.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the interventional drug. -Required if Interventional Drug Sequence (0018,0029) is present. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Interventional Drug when the Coding Scheme Designator (0008,0102) is 99SDM.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Interventional Drug Sequence (018,0029) is present. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The interventional drug that is represented by the Code Value (0008,0100). May be present if Interventional Drug Sequence (0018,0029) is present.
>Intervention Drug Start Time	(0018,0035)	3	Time of administration of the interventional drug. May be present if Interventional Therapy Sequence (0018,0036) is present.
>Intervention Drug Stop Time	(0018,0027)	3	Time of completion of administration of the intervention drug.
> Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the Administration Route. This sequence shall contain exactly one item.
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the Administration Route. Required if Administration Route Code Sequence (0018,0027) is present. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Drug Administration Route when the Coding Scheme Designator (0008,0102) is 99SDM.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the

			Code Meaning (0008,0104). Required if Administration Route Code Sequence (0018,0027) is present. Defined Terms: 99SDM
>> Code Meaning	(0008,0104)	3	The Administration Route that is represented by the Code Value (0008,0100).
>Therapy Description	(0018,0039)	3	Further description in free form text describing the therapy. May be present if Interventional Therapy Sequence (0018,0036) is present.

Note: The value 99SDM from Annex D may be used for the Coding Scheme Designator pointing to ~~the~~ SNOMED/DICOM Microglossary terms of semantic type Interventional Procedure ~~Angiographic Therapy list~~. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

Item #16
Add a new Section C.8.7 with sub-section C.8.7.1 through 8.7.7

C.8.7 X-Ray Modules

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

Table C.8.7.1-1 -- X-Ray Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1C	Required if Multi-Frame Image. Contains the Data Element Tag of the attribute which is used as the Frame increment in Multi-frame image pixel data (See C.7.6.6). Specialized for X-Ray as Enumerated Value: 00181063H = Frame Time(0018,1063); 00181065H = Frame Time Vector(0018,1065).
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression.

			Enumerated Values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression. See C.7.6.1.1.5 Required if Lossy Compression has been performed on the Image.
Image Type	(0008,0008)	1	Image identification characteristics. See C.8.7.1.1.1 for specialization.
Pixel Intensity Relationship	(0028,1040)	1	The relationship between the Pixel sample values and the X-Ray beam intensity. See Section C.8.7.1.1.2.
Samples per Pixel	(0028,0002)	1	Number of samples (color planes) in this image shall have a value of 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Only MONOCHROME2 may be used.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. See Section C.8.7.1.1.6.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. See Section C.8.7.1.1.7.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. See Section C.8.7.1.1.8.
Pixel Representation	(0028, 0103)	1	Data representation of the pixel samples. Shall have the value: 0000H = Unsigned Integer.
Scan Options	(0018,0022)	3	Parameters of scanning sequence. See Section C. 8.7.1.1.4.
Anatomic Region Sequence	(0008,2218)	3	Sequence of one Item that identifies the anatomic region of interest in this image (i.e. external anatomy, surface anatomy, or general region of the body). This anatomic region is placed on the table for examination. See C.8.7.1.1.10.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region. Required if Anatomic Region Sequence (0008,2218) is sent.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Anatomic Region Sequence (0008,2218) is sent. Defined Term: 99SDM

>Code Meaning	(0008,0104)	3	The anatomic region that is represented by the Code Value (0008,0100). May be present only if Anatomic Region Sequence (0008,2218) is sent.
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of one or more Items that modifies the anatomic region of interest in this image (i.e. prone, supine, decubitus right). May be present only if Anatomic Region Sequence (0008,2218) is sent. See C.8.7.1.1.10.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region modifier term. Required if Anatomic Region Modifier Sequence (0008,2220) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Anatomic Region Modifier Sequence (0008,2220) is sent. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic region modifier term that is represented by the Code Value (0008,0100). . May be present only if Anatomic Region Modifier Sequence (0008,2220) is sent.
Primary Anatomic Structure Sequence	(0008,2228)	3	Sequence of one or more Items that identifies the primary anatomic structure of interest in this image. See C.8.7.1.1.11.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary anatomic structure. Required if Primary Anatomic Structure Sequence (0008,2228) is sent.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Primary Anatomic Structure Sequence (0008,2228) is sent. Defined Term: 99SDM
>Code Meaning	(0008,0104)	3	The anatomic structure that is represented by the Code Value (0008,0100). May be present only if Primary Anatomic Structure Sequence (0008,2228) is sent.
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of one or more Items that modifies the primary anatomic structure of interest in this image. May be present only if Primary Anatomic Structure Sequence (0008,2228) is sent. See C.8.7.1.1.11.

>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic structure modifier term. Required if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic structure modifier term that is represented by the Code Value (0008,0100). May be present only if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent.
R Wave Pointer	(0028,6040)	3	Marks the location(s) of the R Wave in the cardiac cycles by referencing frame numbers; frame numbers begin with 1.
Reference Image Sequence	(0008,1140)	1C	A sequence which provides reference to a set of Image SOP Class/Instance identifying other images significantly related to this image. Shall be used to relate each plane to the corresponding plane if Image Type Value 3 is BIPLANE A or BIPLANE B. Encoded as a sequence of items: (0008,1150) and (0008,1155). When relating to the corresponding plane of a Biplane acquisition, only a single item shall be present.
> Reference SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Image Sequence (0008,1140) is present.
> Reference SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Image Sequence (0008,1140) is present.
Derivation Description	(0008,2111)	3	A text description of how this image was derived. See C.8.7.1.1.5 for more explanation.
Acquisition Device Processing Description	(0018,1400)	3	Indicates any visual processing performed on the images prior to exchange. See Section C.8.7.1.1.3.
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 C.7.6.12.

C.8.7.1.1 X-Ray Image Attribute Descriptions

C.8.7.1.1.1 Image Type

The Image Type attribute identifies important image characteristics in a multiple valued data element. For X-Ray, Image Type is specialized as follows:

a) Value 1 shall identify the Pixel Data Characteristics in accordance with Section C.7.6.1.1.2; Enumerated Values are: ORIGINAL and DERIVED;

b) Value 2 shall identify the Patient Examination Characteristics in accordance with Section C.7.6.1.1.2; Enumerated Values are: PRIMARY and SECONDARY;

Note: X-Ray images generally use PRIMARY value for images captured from patient exposure.

c) Value 3 shall identify the image set in terms of the imaging planes. Enumerated Values are:

SINGLE PLANE = Image is a single plane acquisition;

BIPLANE A = Image is the first plane (e.g., Frontal) of a Bi-plane acquisition, collected in a single plane IOD (i.e., the Bi-Plane Sequence Module is not included in the IOD);

BIPLANE B = Image is the second plane (e.g., Lateral) of a Bi-plane acquisition, collected in a single plane IOD (i.e., the Bi-Plane Sequence Module is not included in the IOD);

BIPLANE = Image is both planes of a Bi-plane acquisition (frame data from the A and B planes alternate), collected in a double plane IOD (i.e., the Bi-Plane Sequence Module is included in the IOD).

d) Other Values are implementation specific (optional).

C.8.7.1.1.2 Pixel Intensity Relationship

Pixel Intensity Relationship (0028,1040) shall identify the relationship of the pixel values to the X-Ray beam intensity. Defined terms are:

LIN = Approximately proportional to X-Ray beam intensity;

LOG = Non-linear " Log Function"; A Modality LUT shall be included with the image to allow it to be scaled back to its proportional value to X-Ray beam intensity;

DISP = Ready to be displayed; A Modality LUT may be included with the image to allow it to be scaled back to its proportional value to X-Ray beam intensity. The Attribute Acquisition Device Processing Description may be used to provide some indication on the pre-processing performed to create the ready to be displayed image.

C.8.7.1.1.3 Acquisition Device Processing Description

Acquisition Device Processing Description (0018,1400) provides some indication in human readable text of the digital processing on the images before exchange. Examples of this processing are: edge enhanced, subtracted, time filtered, gamma corrected, convolved (spatially filtered).

C.8.7.1.1.4 Scan Options

The Scan Options attribute identifies any acquisition technique which was used during the acquisition of the image. Defined Terms are

EKG = EKG Event Trigger	PHY = Physiological Event Trigger
TOMO = Tomography	CHASE = Bolus Chasing
STEP = Stepping	ROTA = Rotation

C.8.7.1.1.5 Derivation Description

If an Image is identified to be a Derived image (see C.8.9.1.1.1 Image Type), Derivation Description (0008,2111) is an optional and implementation specific text description of the way the image was derived from an original image. As applied to X-Ray images, it may be used to describe derivation operations such as edge enhancement, temporal filtering, digital subtraction, or other linear and non-linear transformations.

C.8.7.1.1.6 Bits Allocated

For X-Ray Images, Bits Allocated (0028,0100) shall have the Enumerated Value of 8 or 16.

C.8.7.1.1.7 Bits Stored

For X-Ray Images, Bits Stored (0028,0101) shall have the Enumerated Values of 8,10, 12, or 16.

C.8.7.1.1.8 High Bit

For X-Ray Images, High Bit (0028,0102) shall have the Enumerated Value of one less than the value in Bit Stored.

C.8.7.1.1.9 Synchronization of Frame and Curve Times

If a Curve is present and of type ECG, pressure, physiological, respiration, time activity curve, the origin of the coordinate start time (50xx, 0112) shall be the time of frame 1.

C.8.7.1.1.10 Anatomic Region

The general region of the body (e.g. the anatomic region, organ, or body cavity being examined) may be identified by the Anatomic Region Sequence (0008,2218). Characteristics of the anatomic region being examined, such as its orientation relative to gravity (e.g. prone, supine, semi-erect), sub-region (e.g. medial, lateral, superior, inferior, lobe, quadrant), and laterality (e.g. right, left, both), and so on, may be refined by the Anatomic Region Modifier Sequence (0008,2220). These sequences utilize coding triplet encoding to reference anatomic and modifier terms from a Coding Scheme (e.g. SNOMED).

Code Values (0008,0100) for the Anatomic Region Sequence (0008,2218) shall be selected from ~~the~~ SNOMED/DICOM Microglossary terms of semantic type Anatomic Region or Structure ~~Topography module~~ when the Coding Scheme Designator (0008,0102) is 99SDM.

Code Values (0008,0100) for the Anatomic Region Modifier Sequence (0008,2220) shall be selected from ~~the~~ SNOMED/DICOM Microglossary terms of semantic type Anatomic Region Modifier ~~General Linkage/Modifiers module~~ when the Coding Scheme Designator (0008,0102) is 99SDM.

Note: These Data Elements allow the specification of the information encoded by the Body Part Examined (0018,0015) and Patient Position (0018,5100) Data Attributes (in the General Series Module) in a more robust, consistent way.

C.8.7.1.1.11 Primary Anatomic Structure

The specific anatomic structures of interest within the image (e.g. a particular artery within the anatomic region) is identified by the Primary Anatomic Structure Sequence (0008,2228). Characteristics of the anatomic structure, such as its location (e.g. subcapsular, peripheral, central), configuration (e.g. distended, contracted), and laterality (e.g. right, left, both), and so on, may be refined by the Primary Anatomic Structure Modifier Sequence (0008,2230). These sequences utilize triplet encoding to reference anatomic and modifier terms from a Coding Scheme (e.g. SNOMED).

Code Values (0008,0100) for the Primary Anatomic Structure Sequence (0008,2228) shall be selected from ~~the~~ SNOMED/DICOM Microglossary terms of semantic type Anatomic Region or Structure ~~Topography module~~ when the Coding Scheme Designator (0008,0102) is 99SDM.

Code Values (0008,0100) for the Primary Anatomic Structure Modifier Sequence (0008,2230) shall be selected from ~~the~~ SNOMED/DICOM terms of semantic type Anatomic Structure Modifier ~~Microglossary General Linkage/Modifiers~~ module when the Coding Scheme Designator (0008,0102) is 99SDM.

Note: These Data Elements are intended to replace the Anatomic Structure (0008,2208) Data Element.

C.8.7.2 X-Ray Acquisition Module

Table C.8.7.2-1 -- X-Ray Acquisition Module

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	2	Peak kilo voltage output of the X-Ray generator used.
Radiation Setting	(0018,1155)	1	Identify the general level of X-Ray dose exposure. Enumerated values are: 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);
X-Ray Tube Current	(0018,1151)	2C	X-Ray Tube Current in mA. Required if Exposure (0018,1152) is not present.
Exposure Time	(0018,1150)	2C	Duration of X-Ray exposure in msec. See 8.7.2.1.1. Required if Exposure (0018,1152) is not present.
Exposure	(0018,1152)	2C	The product of exposure time and X-Ray Tube Current expressed in mAs. Required if either Exposure Time (0018,1150) or X-Ray Tube Current (0018,1151) are not present.
Grid	(0018,1166)	3	Identify the grid. Defined Terms are: IN = A Grid is positioned; NONE = No Grid is used.
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
Type of Filters	(0018,1161)	3	Type of filter(s) inserted into the X-Ray beam (e.g. wedges).
Intensifier Size	(0018,1162)	3	Diameter of X-Ray intensifier in mm

Field of View Shape	(0018,1147)	3	Shape of the Image Intensifier Field of View. See C.8.7.2.1.2. Defined terms are: ROUND; RECTANGLE;
Field of View Dimension(s)	(0018,1149)	3	Dimensions of the Image Intensifier Field of View in mm. If Rectangle, row dimension followed by column; if Round, diameter.
Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel specified by a numeric pair - row spacing value(delimiter) column spacing value in mm.
Focal Spot	(0018,1190)	3	Nominal focal spot size in mm used to acquire this image.
Image Area Dose Product	(0018,115E)	3	X-Ray dose, measured in dGy*cm*cm, to which the patient was exposed for the acquisition of this image plus any non-digitally recorded fluoroscopy which may have been performed to prepare for the acquisition of this image. Note: The sum of the Image Area Dose Product of all images of a Series or a Study may not result in the actual area dose product to which the patient was exposed.

C.8.7.2.1 X-Ray Acquisition Attribute Descriptions

C.8.7.2.1.1 Exposure Time

Exposure time is the cumulative time the patient received X-Ray exposure during this image (Multi-frame image acquisition). Calculation is pulse width * number of frames.

C.8.7.2.1.2 Field of View

The Field of View Attribute describes the shape and dimensions of the Image Intensifier Field of View (zoom mode). This could be further restricted by the Collimator. See Section C.8.7.3.

C.8.7.3 X-Ray Collimator

An X-Ray Collimator is a device placed close to the X-Ray Source to restrict the span of the X-Ray beam. It is often made of lead shutters. Figure C.8.7.3-1 presents in a graphical form its relationship with the Field Of View Dimensions (0018,1149) and the Intensifier Size (0018,1162) defined in Section C.8.7.2.

Geometry of the collimator is specified with respect to a row and column coordinate system where the origin is the upper left hand pixel. This origin is specified by the values 1,1 for row/column. A row coordinate represent a number of raw spacing (vertical) and a column coordinate represents a column spacing (horizontal). Up to three different collimator shapes may be used and superimposed.

Figure C.8.7.3-1 Relationships of X-Ray Collimator

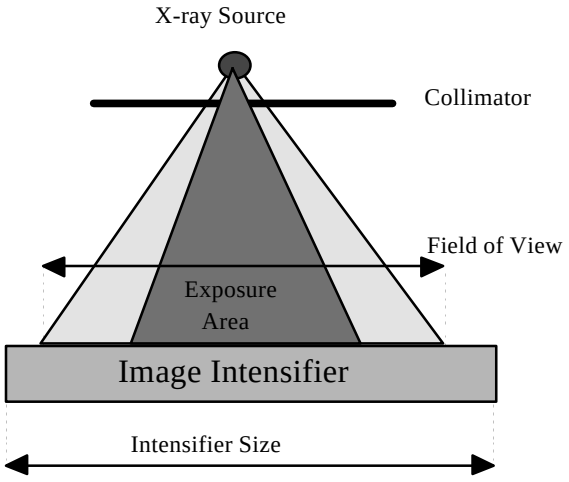


Table C.8.7.3-1 -- X-Ray Collimator Module

Attribute Name	Tag	Type	Attribute Description
Collimator Shape	(0018,1700)	1	Shape(s) of the collimator. Enumerated Values are: RECTANGULAR CIRCULAR POLYGONAL This multi-valued Attribute shall contain at most one of each Enumerated Value.
Collimator Left Vertical Edge	(0018,1702)	1C	Required if Collimator Shape (0018,1500) is RECTANGULAR. Location of the left edge of the rectangular collimator with respect

			to pixels in the image given as column.
Collimator Right Vertical Edge	(0018,1704)	1C	Required if Collimator Shape (0018,1500) is RECTANGULAR. Location of the right edge of the rectangular collimator with respect to pixels in the image given as column.
Collimator Upper Horizontal Edge	(0018,1706)	1C	Required if Collimator Shape (0018,1500) is RECTANGULAR. Location of the upper edge of the rectangular collimator with respect to pixels in the image given as row.
Collimator Lower Horizontal Edge	(0018,1708)	1C	Required if Collimator Shape (0018,1500) is RECTANGULAR. Location of the lower edge of the rectangular collimator with respect to pixels in the image given as row.
Center of Circular Collimator	(0018,1710)	1C	Required if Collimator Shape (0018,1500) is CIRCULAR. Location of the center of the circular collimator with respect to pixels in the image given as row and column.
Radius of Circular Collimator	(0018,1712)	1C	Required if Collimator Shape (0018,1500) is CIRCULAR. Radius of the circular collimator with respect to pixels in the image given as a number of pixels along the row direction.
Vertices of the Polygonal Collimator	(0018,1720)	1C	Required if Collimator Shape (0018,1500) is POLYGONAL. Multiple Values where the first set of two values are: row of the origin vertex; column of the origin vertex; Two or more pairs of values follow and are the row and column coordinates of the other vertices of the polygon collimator. Polygon collimators are implicitly closed from the last vertex to the origin vertex are shall be non-intersecting polygons.

C.8.7.4 X-Ray Table Module

Table C.8.7.4-1 in this Section contains Attributes that describe X-Ray images acquired with movement of the patient imaging table.

Table C.8.7.4-1 — X-Ray Table Module Attributes

Attribute Name	Tag	Type	Attribute Description
Table Motion	(0018,1134)	2	Defined terms: STATIC DYNAMIC
Table Vertical Increment	(0018,1135)	2C	Incremental change in Vertical position of the table relative to first frame of Multi-frame image given in mm. Required if Table Motion is DYNAMIC.
Table Longitudinal Increment	(0018,1137)	2C	Incremental change in Longitudinal position of the table relative to first frame of Multi-frame image in mm. Table motion towards LAO is positive. Required if Table Motion is DYNAMIC.
Table Lateral Increment	(0018,1136)	2C	Incremental change in Lateral position of the table relative to first frame of Multi-frame image given in mm. Table motion towards CRA is positive. Required if Table Motion is DYNAMIC.
Table Angle	(0018,1138)	3	Angle of table plane in degrees relative to horizontal plane [Gravity plane]. Positive values indicate that the head of the table is upwards.

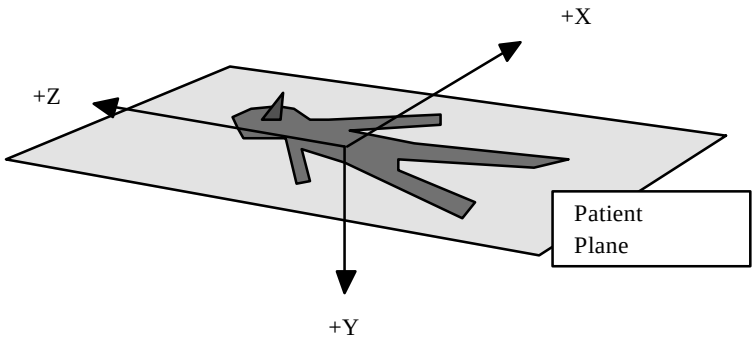
C.8.7.4.1 X-Ray Table Attribute Descriptions

C.8.7.4.1.1 Table Motion Increments

The table moves the Patient with respect to the imaging chain. This is being tracked as a motion of the imaging chain with respect to a coordinate system attached to the patient (assumption is that the patient does not move with respect to the table). The coordinate system origin is fixed with respect to the patient at the time of the first frame. The X-axis is increasing to the left hand side of the patient. The y-axis is increasing to the posterior side of the patient. The Z-axis is increasing toward the head of the patient. The X and Z axis as drawn in Figure C.8.7.4.1.1-1 are parallel to the Patient Plane.

NOTE: Table motion causes the apparent locus of imaging to move in the opposite direction. For instance, with table motion towards LAO, the area of the patient imaged moves toward RAO.

Figure C.8.7.4-1 Table Motion Vector Coordinates



C.8.7.5 XA Positioner Module

Table C.8.7.5-1 contains IOD Attributes that describe a c-arm positioner typically used in acquiring X-Ray Angiographic Images. The coordinate system used to track the positioner is defined in reference to the patient. The definition of coordinates with respect to the equipment is not supported. Furthermore, this module does not describe the movement of the Patient.

Note: The scope of the XA IOD is to address images produced on acquisition equipment equipped with an X-Ray source and an image Receptor positioned by what is general called a c-arm For clinical areas other than Angiography which are using a c-arm to position the X-Ray source and image receptor (e.g. Interventional Procedures and Myelography and Biopsy/Localization), the X-Ray Angiography Image Object should be also used. Although the object is optimized for c-arm systems, it may also be used by other systems which support a similar coordinate system, such as some RF systems.

Table C.8.7.5-1 - XA Positioner Module Attributes

Attribute Name	Tag	Type	Attribute Description
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to isocenter (center of field of view).
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center.
Estimated Radiographic Magnification Factor	(0018,1114)	3	Ratio of Source Image Distance (SID) over Source Object Distance (SOD).
Positioner Motion	(0018,1500)	2C	Used to describe the activity of the imaging devices. Defined terms: DYNAMIC, STATIC. Required if Multi-frame data. . See 8.7.5.1.1.
Positioner Primary Angle	(0018,1510)	2	Position of the X-Ray Image Intensifier about the patient from the RAO to LAO direction where movement from RAO to vertical is positive. See 8.7.5.1.2.
Positioner Secondary Angle	(0018,1511)	2	Position of the X-Ray Image Intensifier about the patient from the CAU to CRA direction where movement from CAU to vertical is positive. See 8.7.5.1.2
Positioner Primary Angle Increment	(0018,1520)	2C	Incremental change in primary positioner angle for each frame. See 8.7.5.1.3. Required if Positioner Motion is DYNAMIC.
Positioner Secondary Angle Increment	(0018,1521)	2C	Incremental change in secondary positioner angle for each frame. See 8.7.5.1.3. Required if Positioner Motion is DYNAMIC.
Detector Primary Angle	(0018,1530)	3	Angle of the X-Ray beam in the row direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted towards higher numbered columns. Negative values indicate that the X-Ray beam is tilted towards lower numbered columns. See 8.7.5.1.4.
Detector Secondary Angle	(0018,1531)	3	Angle of the X-Ray beam in the column direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted towards lower numbered rows. Negative values indicate

			that the X-Ray beam is tilted towards higher numbered rows. See 8.7.5.1.4.

C.8.7.5.1 XA Positioner Attribute Descriptions

C.8.7.5.1.1 Positioner Motion

Positioner Motion attribute is STATIC if the imaging table moves during a multi-frame acquisition, but the X-Ray positioner do not move.

Note: If the positioner undergoes translation (non-rotational movement) during the acquisition, then that motion shall be described by an opposite table motion (See section C.8.7.4)

C.8.7.5.1.2 Positioner Primary and Secondary Angles

The definitions of Positioner Angles shall be with respect to the patient as illustrated in Figures C.8.7.5.1.2-1 and C.8.7.5.1.2-2. Zero degree is referenced to the origin perpendicular to the patient's chest. The Positioner Primary Angle definition is like longitude (in the equatorial plan); the Positioner Secondary Angle definition is like latitude (in the sagittal plane). The Positioner Angle attributes apply to the first frame of a multi-frame image. The valid range of Primary Positioner Angle is -180 to +180 degrees and the Secondary Positioner Angle range is -90 to + 90 degrees.

The Patient Plane is defined by the isocenter of the imaging device and slices through the patient such that it is perpendicular to the sagittal plane of the body.. The Primary Axis of rotation is defined at the intersection of the Patient Plane and of the Sagittal Plane. The Positioner Primary Angle is defined in the transaxial plane at the isocenter with zero degrees in the direction perpendicular to the patient's chest and + 90 degrees at the Patient left hand side (LAO) and -90 at the Patient right hand side (RAO). The valid range of Primary Positioner Angle is -180 to +180 degrees.

The Secondary Axis is in the Patient Plane and is perpendicular to the Primary Axis at the isocenter. The Positioner Secondary Angle is defined in the Sagittal Plane at the isocenter with zero degrees in the direction perpendicular to the patient's chest. +90 degrees corresponds to the cranial direction. The Secondary Positioner Angle range is -90 to + 90 degrees.

At a 0 angle for both the Primary Angle (0018,1510) and Secondary Angle (0018,1511) , the patient faces the Image Intensifier.

The Positioner Primary Angle (0018,1510) and Secondary Angle (0018,1511) apply to the first frame of a multi-frame image.

Figure C.8.7.5.1.2-1 Positioner Primary Angle

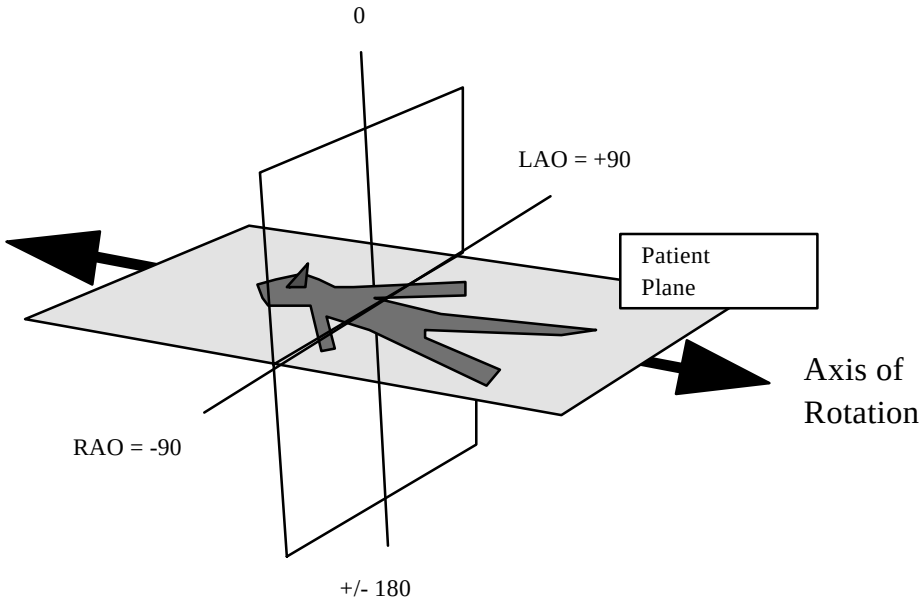
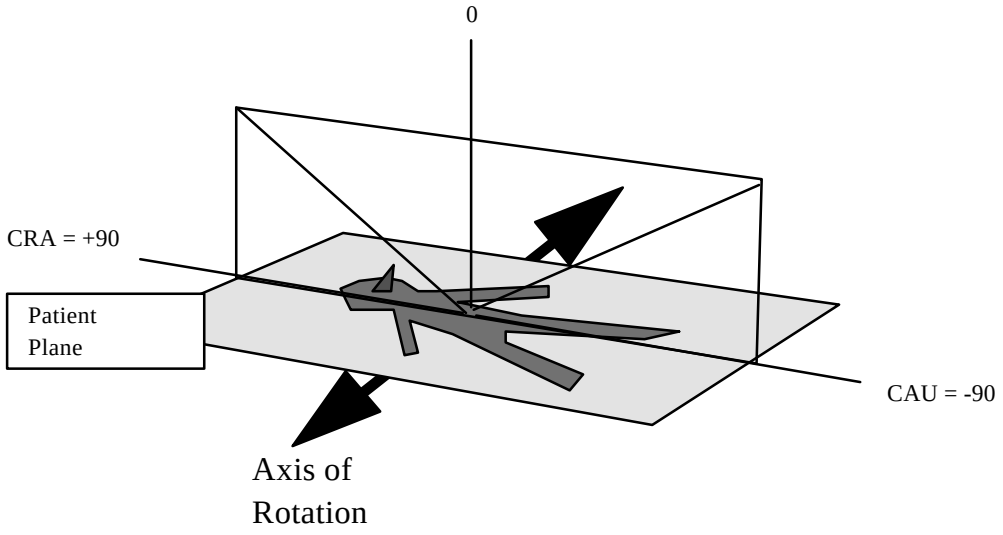


Figure C.8.7.5.1.2-2 Positioner Secondary Angle



C.8.7.5.1.3 Positioner Angle Increments

If the positioner angles change during acquisition of a multi-frame image, the Positioner Angle Increment attributes describe the angular change per frame.

If the change in positioner angle is nominally constant for each frame, these fields may contain a single value of the average angular change per frame. Alternatively, the fields may contain a vector of offsets from the (initial) Positioner Angle attributes, with one value for each frame in the multi-frame image. The number of values in the Positioner Angle Increment attributes must be one, or must be equal to the Number of Frames attribute (0028,0008) in the Multi-Frame Module (see Section C.7.6.6).

NOTE: It is permissible to generate a vector of the absolute positioner angles in the Positioner Angle Increment attributes, and set the Positioner Primary and Secondary Angle attributes to value 0.

C.8.7.5.1.4 Detector Primary and Secondary Angles

Detector Angles are defined in a fashion similar to the positioner angles, except that the angle of the central x-ray beam vector is relative to the detector plane rather than the patient plane. The central x-ray beam vector is defined as the vector from the x-ray source through the isocenter to the detector plane. Zero degree is referenced to the normal to the detector plane pointing away from the x-ray source. The Detector Angle attributes apply to the first frame of a multi-frame image. The valid range of the Detector Angles is -90 to + 90 degrees.

The Primary Axis of rotation is defined along the line in the column direction of the detector plane which intersects the central x-ray beam vector. The Detector Primary Angle is defined in the plane perpendicular to the Primary Axis of rotation at the point where the central x-ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane and -90 degrees at the left hand side of the image (i.e., toward column 1) and +90 at the right hand side of the image (i.e., toward the highest numbered column). The valid range of Primary Detector Angle is -90 to +90 degrees.

The Secondary Axis is in the detector plane and is perpendicular to the Primary Axis at the intersection of the beam vector with the detector plane (i.e., it is along the row direction). The Detector Secondary Angle is defined in the plane perpendicular to the Secondary Axis at the point where the central x-ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane. +90 degrees corresponds to the direction toward the top of the image. The Secondary Detector Angle range is -90 to + 90 degrees.

Item #17
Modify the Overlay Plane Module in Section C.9.2 as follows:
All modifications to the existing table are listed with a BOLD font

C.9.2 Overlay Plane Module

Table C.9.2-1 contains Attributes that describe characteristics of an Overlay Plane.

Table C.9.2-1 - Overlay Plane Module Attributes

Attribute Name	Tag	Type	Attribute Description
Rows	(60xx,0010)	1	Number of rows in Overlay.
Columns	(60xx,0011)	1	Number of columns in Overlay.
Overlay Type	(60xx,0040)	1	Indicates whether this overlay represents a region of interest or other graphics. Enumerated Values: G = Graphics; R = ROI.
Origin	(60xx,0050)	1	Location of first overlay point with respect to pixels in the image, given as row and column. **Rows and columns are numbered from 1. Row is the vertical offset and column is the horizontal offset.**
Bits Allocated	(60xx,0100)	1	Number of bits allocated in the overlay.
Bit Position	(60xx,0102)	1	Bit in which overlay is stored.
... No changes to the remainder of table which is not reproduced here			

Item #18
Modify the Multi-frame Overlay Module in Section C.9.3 as follows:
All modifications to the existing table are listed with a BOLD font

C.9.3 Multi-frame Overlay Module

Table C.9.3 specifies the Attributes of a Multi-frame overlay.

Table C.9-3-- Multi-frame Overlay Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Frames in Overlay	(60xx,0015)	1	Number of Frames in Overlay. Required if Overlay data contains multiple frames.
Image Frame Origin	**(60xx,0051)**	**3**	**Frame number of Multi-frame Image to which this overlay applies; frames are numbered from 1.**

C.9.3.1 Multi-frame Overlay Attribute Descriptions

C.9.3.1.1 Number of Frames in Overlay

A Multi-frame Overlay is defined as an Overlay whose overlay data consists of a sequential set of individual Overlay frames. A Multi-frame Overlay is transmitted as a single contiguous stream of overlay data. Frame delimiters are not contained within the data stream.

Each individual frame shall be defined (and thus can be identified) by the Attributes in the Overlay Plane Module (see C.9.2).

The total number of frames contained within a Multi-frame Overlay is conveyed in the Number of Frames in Overlay (60xx,0015).

The frames within a Multi-frame Overlay shall be conveyed as a logical sequence. If Multi-frame Overlays are related to a Multi-frame Image, the order of the Overlay Frames are one to one with the order of the Image frames. **If Image Frame Origin (60xx,0051) is present, the Overlay frames are applied one to one to the Image frames, beginning at the indicated frame number.** Otherwise, no attribute is used to indicated the sequencing of the Overlay Frames.

The Number of Frames in Overlay (60xx,0015) plus the Image Frame Origin (60xx,0051) minus 1 shall be less than or equal to the total number of frames in the Multi-frame Image.

If the Overlay data are embedded in the pixel data, then the Image Frame Origin (60xx,0051) must be 1 and the Number of Frames in Overlay (60xx,0015) must equal the number of frames in the Multi-frame Image.

Item #19
Add Section C.9.4 Bi-plane Overlay Modality

C.9.4 Bi-Plane Overlay Module

Table C.9.4-1 describes the Attributes associated with an overlay when it is associated with a bi-plane image.

Table C.9.4-1— Bi-Plane Overlay Module Attributes

Attribute Name	Tag	Type	Attribute Description
Overlay Planes	(60xx,0012)	1	Number of planes.
Overlay Plane Origin	(60xx,0052)	2C	Plane to which overlay applies. Required if Overlay is one plane in a bi-plane image. If no value is present, overlay is applied to both frames.

C.9.4.1 Bi-Plane Overlay Attribute Descriptions

An overlay associated with a bi-plane image may itself be either a single plane or bi-plane, as indicated by the Overlay Planes attribute (value of 1 or 2). If the overlay is a single plane, it is applied to the modality image plane specified in the Overlay Plane Origin attribute. If the overlay is bi-plane (Overlay Planes attribute value of 2), each overlay plane shall be applied to the corresponding modality image plane using the Origin attribute of the Overlay Plane Module (see Section C.9.2) and Image Frame Origin attribute of Multi-frame Overlay Module (See section C.9.3).

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Part 4 Addendum
X-Ray Angiographic Image Storage SOP Class

Item #20
Add the following to the second bullet of "Conformance Statement for an SCP in Section B.4.3.2 of Part 4:

The Conformance Statement shall document the policies concerning the Attribute Lossy Image Compression (0028,2110).

Item #21
Add the following to Section B.5 of Part 4:

B.5 Standard SOP Classes

SOP Class Name	SOP Class UID
X-Ray Angiographic Image Storage	**1.2.840.10008.5.1.4.1.1.12.1**
X-Ray Angiographic Bi-Plane Image Storage	**1.2.840.10008.5.1.4.1.1.12.3**

ACC-ACR-NEMA

Digital Imaging and Communications in Medicine (DICOM)

Part 6 Addendum
X-Ray Angiographic Data Dictionary

Item #22
Add the following Data Elements to Part 6 Section 6:

Tag	Name	VR	VM
(0008,1048)	Physician (s) of Record	PN	1-n
(0008,2218)	Anatomic region Sequence	SQ	1
(0008,2220)	Anatomic Region Modifier Sequence	SQ	1
(0008,2228)	Primary Anatomic Structure Sequence	SQ	1
(0008,2230)	Primary Anatomic Structure Modifier Sequence	SQ	1

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Tag	Name	VR	VM
(0018,0012)	Contrast/Bolus Agent Sequence	SQ	1
(0018,002A)	Additional drug Sequence	SQ	1
(0018,0029)	Interventional Drug Sequence	SQ	1
(0018,0014)	Contrast/Bolus Administration Route Sequence	SQ	1
(0018,0036)	Interventional Therapy Sequence	SQ	1
(0018,0037)	Therapy Type	CS	1
(0018,0038)	Interventional Status	CS	1
(0018,0039)	Therapy Description	CS	1
(0018,1046)	Contrast Flow Rate(s)	DS	1-n
(0018,1047)	Contrast/Flow Duration(s)	DS	1-n
(0018,1048)	Contrast/Bolus Ingredient	CS	1
(0018,1049)	Contrast/Bolus Ingredient Concentration	DS	1
(0018,1114)	Estimated Radiographic Magnification Factor	DS	1
(0018,1134)	Table Motion	CS	1
(0018,1135)	Table Vertical Increment	DS	1-n
(0018,1136)	Table Lateral Increment	DS	1-n
(0018,1137)	Table Longitudinal Increment	DS	1-n
(0018,1138)	Table Angle	DS	1
(0018,1154)	Average Pulse Width	DS	1
(0018,1155)	Radiation Setting	CS	1
(0018,115A)	Radiation Mode	CS	1
(0018,115E)	Image Area Dose Product	DS	1
(0018,1161)	Type of Filters	LO	1-n
(0018,1162)	Intensifier Size	DS	1
(0018,1164)	Imager Pixel Spacing	DS	2

(0018,1166)	Grid	CS	1
(0018,1600)	Shutter Shape	CS	1
(0018,1500)	Positioner Motion	CS	1
(0018,1510)	Positioner Primary Angle	DS	1
(0018,1511)	Positioner Secondary Angle	DS	1
(0018,1520)	Positioner Primary Angle Increment	DS	1-n
(0018,1521)	Positioner Secondary Angle Increment	DS	1-n
(0018,1530)	Detector Primary Angle	DS	1
(0018,1531)	Detector Secondary Angle	DS	1
(0018,1600)	Shutter Shape	CS	1-3
(0018,1602)	Shutter Left Vertical Edge	IS	1
(0018,1604)	Shutter Right Vertical Edge	IS	1
(0018,1606)	Shutter Upper Horizontal Edge	IS	1
(0018,1608)	Shutter Lower Horizontal Edge	IS	1
(0018,1610)	Center of Circular Shutter	IS	2
(0018,1612)	Radius of Circular Shutter	IS	1
(0018,1620)	Vertices of the Polygonal Shutter	IS	2-2n
(0018,1700)	Collimator Shape	CS	1-3
(0018,1702)	Collimator Left Vertical Edge	IS	1
(0018,1704)	Collimator Right Vertical Edge	IS	1
(0018,1706)	Collimator Upper Horizontal Edge	IS	1
(0018,1708)	Collimator Lower Horizontal Edge	IS	1
(0018,1710)	Center of Circular Collimator	IS	2
(0018,1712)	Radius of Circular Collimator	IS	1
(0018,1720)	Vertices of the Polygonal Collimator	IS	2-2n

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Tag	Name	VR	VM
(0028,0012)	Planes	US	1
(0028,0110)	Smallest Image Pixel Value in Plane	US or SS	1
(0028,0111)	Largest Image Pixel Value in Plane	US or SS	1
(0028,1040)	Pixel Intensity Relationship	CS	1
(0028,1090)	Recommended Viewing Mode	CS	1
(0028,2110)	Lossy Image Compression	CS	1
(0028,5000)	Bi-Plane Acquisition Sequence	SQ	1
(0028,6010)	Representative Frame Number	US	1
(0028,6020)	Frame numbers Of Interest (FOI)	US	1-n
(0028,6022)	Frame Of Interest Description	LO	1-n
(0028,6030)	Mask Pointer(s)	US	1-n
(0028,6040)	R Wave Pointer	US	1-n
(0028,6100)	Mask Subtraction Sequence	SQ	1
(0028,6101)	Mask Operation	CS	1
(0028,6102)	Applicable Frame Range	US	2-2n

(0028,6110)	Mask Frame Numbers	US	1-n
(0028,6112)	Contrast Frame Averaging	US	1
(0028,6114)	Mask Sub-pixel Shift	FL	2
(0028,6120)	TID Offset	SS	1
(0028,6190)	Mask Operation Explanation	ST	1

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Tag	Name	VR	VM
(0050,0004)	Calibration Object	CS	1
(0050,0010)	Device Sequence	SQ	1
(0050,0014)	Device Length	DS	1
(0050,0016)	Device Diameter	DS	1
(0050,0017)	Device Diameter units	CS	1
(0050,0018)	Device Volume	DS	1
(0050,0019)	Inter-marker Distance	DS	1
(0050,0020)	Device Description	LO	1
(60xx,0012)	Overlay Planes	US	1
(60xx,0051)	Image Frame Origin	US	1
(60xx,0052)	Overlay Plane Origin	US	1

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Item #23
Add the following UID to Part 6 Annex A:

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UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.5.1.4.1.1.12.1	**X-Ray Angiographic Image Storage**	**SOP Class**	**Part 4**
1.2.840.10008.5.1.4.1.1.12.3	**X-Ray Angiographic Bi-Plane Image Storage**	**SOP Class**	**Part 4**

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