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Digital Imaging and Communications in Medicine (DICOM)

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Supplement 125: Breast Tomosynthesis Image Storage SOP Class

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Scope and Field of Application

62 This supplement to the DICOM standard introduces the new Breast Tomosynthesis Image Storage SOP
Class, based on the X-Ray 3D image storage SOP Classes. Both are based on the multi-frame concepts
64 introduced with the Enhanced MR Image SOP Class.

The scope of this Supplement is to customize the X-Ray 3D multi-dimensional storage SOP Classes for
66 storage and exchange of the 3D volume or volumes created from digital breast tomosynthesis x-ray
projections. The slices of the volumes are in the Cartesian format, i.e., non-curved slices defined by
68 position and orientation properties. This SOP Class is intended for storage and exchange of only the 3D
volumes (i.e. reconstructed slices). If the source projection x-ray images are exchanged, this should be
70 done using the existing Digital Mammography X-Ray Image Storage SOP Classes.

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Changes to NEMA Standards Publication PS 3.2-2008

Digital Imaging and Communications in Medicine (DICOM)

82

Part 2: Conformance

Add new SOP Class in Table A.1-2

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**Table A.1-2
UID VALUES**

UID Value	UID NAME	Category
...		
1.2.840.10008.5.1.4.1.1.13.1.3	Breast Tomosynthesis Image Storage	Transfer
...		

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Changes to NEMA Standards Publication PS 3.3-2008

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Part 3: Information Object Definitions

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98 **Add new IOD in Table A.1-1**

IODs Modules	<u>Breast Tomo</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>
<u>Enhanced Mammography Series</u>	<u>M</u>
Frame of Reference	<u>M</u>
Synchronization	<u>C</u>
General Equipment	<u>M</u>
Enhanced General Equipment	<u>M</u>
Image Pixel	<u>M</u>
Enhanced Contrast/Bolus	<u>C</u>
Device	<u>U</u>
Intervention	<u>U</u>
Acquisition Context	<u>M</u>
Multi-frame Functional Groups	<u>M</u>
Multi-frame Dimension	<u>U</u>
Image – Equipment Coordinate Relationship	<u>U</u>
X-Ray 3D Image	<u>M</u>
<u>Breast Tomosynthesis Contributing Sources</u>	<u>U</u>
<u>Breast Tomosynthesis Acquisition</u>	<u>U</u>
X-Ray 3D Reconstruction	<u>U</u>
<u>Breast View</u>	<u>M</u>
SOP Common	<u>M</u>

Add new IOD to Annex A

100 **A.X BREAST TOMOSYNTHESIS IMAGE INFORMATION OBJECT DEFINITION**

A.X.1 Breast Tomosynthesis Image IOD Description

102 This Section defines the Information Object for multi-dimensional reconstructed breast tomosynthesis X-
Ray Images that includes those data elements and information objects necessary for the interchange of
104 multi-dimensional breast tomosynthesis X-Ray volumes.

Note: This IOD is not intended for interchange of source projection x-ray images.

106

A.X.2 Breast Tomosynthesis Image IOD Entity-Relationship Model

108 The E-R Model in Section A.1.2 depicts those components of the DICOM Application Information Model
that directly reference the Breast Tomosynthesis Image IOD.

110 **A.X.3 Breast Tomosynthesis Image IOD Module Table**

**Table A.X-1
BREAST TOMOSYNTHESIS IMAGE IOD MODULES**

112

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 Mammography Series	C.8.11.X	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C – Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C – Required if contrast media was applied.
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension Module	C.7.6.17	U

Image – Equipment Coordinate Relationship	C.7.6.21	U
X-Ray 3D Image	C.8.21.1	M
Breast Tomosynthesis Contributing Sources	C.8.21.2.3	U
Breast Tomosynthesis Acquisition	C.8.21.3.4	U
X-Ray 3D Reconstruction	C.8.21.4	U
Breast View	C.8.21.6	M
SOP Common	C.12.1	M

114 **A.X.3.1 Breast Tomosynthesis Image IOD Content Constraints**

A.X.3.1.1 Restrictions for Standard Extended SOP Classes

116 The Overlay Plane Module, Modality LUT Module, VOI LUT Module and Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the Breast Tomosynthesis Image.

118 Note: The VOI LUT function is provided by a Frame VOI LUT Functional Group.

120 **A.X.4 Breast Tomosynthesis Image Functional Group Macros**

122 Table A.X-2 specifies the use of the Functional Group macros used in the Multi-frame Functional Groups Module for the Breast Tomosynthesis Image IOD.

**Table A.X-2
BREAST TOMOSYNTHESIS IMAGE FUNCTIONAL GROUP MACROS**

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M– May not be used as a Shared Functional Group.
Plane Position	C.7.6.16.2.3	M
Plane Orientation	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C – Required if the Image Type (0008,0008) Value 1 equals DERIVED.
Frame Anatomy	C.7.6.16.2.8	M
Identity Pixel Value Transformation	C.7.6.16.2.9b	M
Frame VOI LUT With LUT	C.7.6.16.2.10b	M
Real World Value Mapping	C.7.6.16.2.11	U
Contrast/Bolus Usage	C.7.6.16.2.12	C – Required if the Enhanced Contrast/Bolus Module is present.
X-Ray 3D Frame Type	C.8.21.5.1	M – May not be used as a Shared Functional Group.

126 **A.X.4.1 Breast Tomosynthesis Image Functional Group Macros Content Constraints**

A.X.4.1.1 Frame Anatomy Functional Group Macro

128 The Defined Context ID for the Anatomic Region Sequence (0008,2218) shall be CID 4013.

Add new Identity Pixel Value Transformation Macro

130 **C.7.6.16.2.9b Identity Pixel Value Transformation Macro**

132 Table C.7.6.16-10b specifies the attributes of the Identity Pixel Value Transformation Functional Group macro.

134 Note: This Macro constrains the Modality LUT Transformation step in the grayscale rendering pipeline to be an identity transformation.

136 **Table C.7.6.16-10b
IDENTITY PIXEL VALUE TRANSFORMATION MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Pixel Value Transformation Sequence	(0028,9145)	1	Contains the attributes involved in the transformation of stored pixel values. Only a single Item shall be permitted in this sequence.
>Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV + b. Enumerated Value: 0
>Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052). Enumerated Value: 1
>Rescale Type	(0028,1054)	1	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See C.11.1.1.2 for further explanation. Enumerated Value: US - Unspecified

138

Add new Frame VOI LUT With LUT Transformation Macro

140 **C.7.6.16.2.10b Frame VOI LUT With LUT Macro**

142 Table C.7.6.16-11b specifies the attributes of the Frame VOI LUT With LUT Functional Group macro. This macro contains one or more sets of linear or sigmoid window values and/or one or more sets of lookup tables.

144 **Table C.7.6.16-11b
FRAME VOI LUT WITH LUT MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Frame VOI LUT Sequence	(0028,9132)	1	The VOI LUT transformations applied to this frame. Only one item is permitted in this sequence.
>Include VOI LUT Macro Table C.11-2b			

146

Factor out macro for describing collimators from existing module

148 **C.8.7.3 X-Ray Collimator**

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**Table C.8-28
X-RAY COLLIMATOR MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Collimator Shape	(0018,1700)	1	Shape(s) of the collimator. Enumerated Values: RECTANGULAR CIRCULAR POLYGONAL This multi-valued Attribute shall contain at most one of each Enumerated Value.
<u>Include 'X-Ray Collimator Dimensions Macro' Table C.8-28b</u>			

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**Table C.8-28b
X-RAY COLLIMATOR DIMENSIONS MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Collimator Left Vertical Edge	(0018,1702)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the left edge of the rectangular collimator with respect to pixels in the image given as column. See C.8.7.3.1.1.
Collimator Right Vertical Edge	(0018,1704)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the right edge of the rectangular collimator with respect to pixels in the image given as column. See C.8.7.3.1.1.
Collimator Upper Horizontal Edge	(0018,1706)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the upper edge of the rectangular collimator with respect to pixels in the image given as row. See C.8.7.3.1.1.
Collimator Lower Horizontal Edge	(0018,1708)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the lower edge of the rectangular collimator with respect to pixels in the image given as row. See C.8.7.3.1.1.
Center of Circular Collimator	(0018,1710)	1C	Required if a value of Collimator Shape (0018,1700) is CIRCULAR. Location of the center of the circular collimator with respect to pixels in the image given as row and column. See C.8.7.3.1.1.
Radius of Circular Collimator	(0018,1712)	1C	Required if a value of Collimator Shape (0018,1700) is CIRCULAR. Radius of the

			circular collimator with respect to pixels in the image given as a number of pixels along the row direction. See C.8.7.3.1.1.
Vertices of the Polygonal Collimator	(0018,1720)	1C	Required if a value of Collimator Shape (0018,1700) 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 and all edges shall be non-intersecting except at the vertices.

156 **Factor out macro for describing grids from existing module**

C.8.7.11 X-Ray Grid Module

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**Table C.8-36
 X-RAY GRID MODULE ATTRIBUTES**

160

Attribute Name	Tag	Type	Attribute Description
Grid	(0018,1166)	3	Identifies the grid. May be multi-valued. Defined Terms are: FIXED FOCUSED RECIPROCATING PARALLEL CROSSED NONE

Include 'X-Ray Grid Description Macro' Table C.8-36b

162

**Table C.8-36b
 X-RAY GRID DESCRIPTION MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Grid Absorbing Material	(0018,7040)	3	The X-Ray absorbing material used in the grid.
Grid Spacing Material	(0018,7041)	3	The spacing material used in the grid.
Grid Thickness	(0018,7042)	3	The thickness in mm of the X-Ray absorbing material used in the grid.
Grid Pitch	(0018,7044)	3	The pitch in mm of the X-Ray absorbing material used in the grid.

Grid Aspect Ratio	(0018,7046)	3	Ratio of the vertical spacing and horizontal spacing of the X-Ray absorbing material used in the grid. Specified by a pair of integer values where the first value is the vertical size, and the second value is the horizontal size.
Grid Period	(0018,7048)	3	Period in mSec of reciprocation cycle. Only meaningful if a value of Grid (0018,1166) is RECIPROCATING.
Grid Focal Distance	(0018,704C)	3	Focal distance in mm of a FOCUSED grid.
Grid ID	(0018,1006)	3	Identifier of the grid.

164

Use the new macros where appropriate in the existing X-Ray 3D macros, and “unfactor” attributes that need to be different in the different IODs

166

C.8.21.3.1.1 X-Ray 3D General Shared Acquisition Macro

Table C.8.21.3.1.1-1 describes the X-Ray 3D General Shared Acquisition Macro that specifies the attributes that are applicable for all the projection images belonging to this application context.

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**Table C.8.21.3.1.1-1
X-RAY 3D GENERAL SHARED ACQUISITION MACRO**

Attribute Name	Tag	Type	Attribute Description
Source Image Sequence	(0008,2112)	1C	A Sequence that identifies the set of Images that constitute this acquisition context. Required if the reconstruction is created from DICOM SOP Instances. Note: The attribute is absent in the case where the images used to create the volume are not available as SOP Instances, e.g., the volume was directly generated by acquisition system. One or more Items mayshall be included in this Sequence.
<i>>Include 'Image SOP Instance Reference Macro' Table 10-3</i>			
Field of View Shape	(0018,1147)	1C	Shape of the Field of View in the referenced images. Enumerated Values: —— RECTANGLE —— ROUND —— HEXAGONAL Required if present and consistent in the contributing SOP Instances.

Field of View Dimension(s) in Float	(0018,9461)	1C	<p>Dimensions in mm of the Field of View in the <u>referenced source projection</u> images. If Field of View Shape (0018,1147) is:</p> <p>RECTANGLE: row dimension followed by column.</p> <p>ROUND: diameter.</p> <p>HEXAGONAL: diameter of the circle circumscribing the hexagon.</p> <p>Required if present and consistent in the contributing SOP Instances. <u>Required if Modality (0008,0060) is MG.</u></p>
Field of View Origin	(0018,7030)	1C	<p>Offset of the TLHC of a rectangle circumscribing the Field of View in the referenced images, before rotation or flipping, from the TLHC of the physical detector area measured in physical detector pixels as a row offset followed by a column offset.</p> <p>See C.8.11.4.1.1 for further explanation.</p> <p>Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR.</p>
Field of View Rotation	(0018,7032)	1C	<p>Clockwise rotation in degrees of Field of View in the referenced images, relative to the physical detector.</p> <p>Enumerated Values: 0, 90, 180, 270</p> <p>See C.8.11.4.1.1 for further explanation.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
Field of View Horizontal Flip	(0018,7034)	1C	<p>Whether or not a horizontal flip has been applied to the Field of View in the referenced images, after rotation relative to the physical detector as described in Field of View Rotation (0018,7032).</p> <p>Enumerated Values: NO YES</p> <p>See C.8.11.4.1.1 for further explanation.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>

Grid	(0018,1166)	1C	<p>Identifies the grid. May be multi-valued. <u>See Attribute Description in Section C.8.7.11 for Defined Terms.</u></p> <p>Defined Terms are:</p> <p>_____ FIXED</p> <p>_____ FOCUSED</p> <p>_____ RECIPROCATING</p> <p>_____ PARALLEL</p> <p>_____ CROSSED</p> <p>_____ NONE</p> <p>Required if present and consistent in the contributing SOP Instances. <u>Required if Modality (0008,0060) is MG.</u></p>
<u>Include 'X-Ray Grid Description Macro' Table C.8-36b</u>			
X-Ray Receptor Type	(0018,9420)	1C	<p>Identifies the type of X-Ray receptor used.</p> <p>Enumerated Values:</p> <p>_____ IMG_INTENSIFIER</p> <p>_____ DIGITAL_DETECTOR</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
KVP	(0018,0060)	1C	<p>Average of the peak kilo voltage outputs of the X-Ray generator used for all frames.</p> <p>Required if present and consistent in the contributing SOP Instances. <u>Required if Modality (0008,0060) is MG.</u></p>
X-Ray Tube Current in mA	(0018,9330)	1C	<p>Average of the nominal X-Ray tube currents in milliamperes for all frames.</p> <p>Required if present and consistent in the contributing SOP Instances. <u>Required if Modality (0008,0060) is MG.</u></p>
Exposure Time in ms	(0018,9328)	1C	<p>Total (cumulative) dDuration of X-Ray exposure <u>for all frames,</u> in milliseconds. See C.8.7.2.1.1.</p> <p>Required if present and consistent in the contributing SOP Instances. <u>Required if Modality (0008,0060) is MG.</u></p>
Exposure in mAs	(0018,9332)	1C	<p>The <u>total (cumulative) exposure for all frames,</u> expressed in milliampereseconds, for example calculated from Exposure Time and X-Ray Tube Current.</p> <p>Required if present and consistent in the contributing SOP Instances. <u>Required if Modality (0008,0060) is MG.</u></p>

Contrast/Bolus Agent	(0018,0010)	1C	Contrast or bolus agent. Required if present and consistent in the contributing SOP Instances.
Contrast/Bolus Agent Sequence	(0018,0012)	1C	Sequence that identifies the contrast agent. One or more Items may be present. Required if present and consistent in the contributing SOP Instances. <u>Required if Modality (0008,0060) is MG and contrast media was applied.</u>
>Include 'Code Sequence Macro' Table 8.8-1			Baseline Context ID is 12.
Start Acquisition DateTime	(0018,9516)	1C	Start date and time of that part of an acquisition used for this acquisition context. Required if present and consistent in the contributing SOP Instances.
End Acquisition DateTime	(0018,9517)	1C	End date and time of that part of an acquisition used for this acquisition context. Required if present and consistent in the contributing SOP Instances.

C.8.21.3.1.2 X-Ray 3D General Per Projection Acquisition Macro

174 Table C.8.21.3.1.2-1 describes the X-Ray 3D General Per Projection Acquisition Macro that specifies the attributes that are applicable for a single projection belonging to this application context.

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**Table C.8.21.3.1.2-1
X-RAY 3D GENERAL PER PROJECTION ACQUISITION MACRO**

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	1C	Exact peak kilo voltage output of the X-Ray generator used for this projection. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
X-Ray Tube Current in mA	(0018,9330)	1C	Exact Nominal X-Ray tube current in milliamperes applied during the Frame Acquisition Duration (0018,9220) for this projection. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Frame Acquisition Duration	(0018,9220)	1C	The actual amount of time [in milliseconds] that was used to acquire data for this projection. See C.7.6.16.2.2.1 and C.7.6.16.2.2.3 for further explanation. Required if present and consistent in the contributing SOP Instances.
Collimator Shape	(0018,1700)	1C	Shape(s) of the collimator. Enumerated Values: RECTANGULAR CIRCULAR POLYGONAL This multi-valued Attribute shall contain at most one of each Enumerated Value. Required if present and consistent in the contributing SOP Instances.
<i>Include 'X-Ray Collimator Dimensions Macro' Table C.8-28b</i>			
Collimator Left Vertical Edge	(0018,1702)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the left edge of the rectangular collimator with respect to pixels in the image given as column. See C.8.7.3.1.1.
Collimator Right Vertical Edge	(0018,1704)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the right edge of the rectangular collimator with respect to pixels in the image given as column. See C.8.7.3.1.1.

Collimator Upper Horizontal Edge	(0018,1706)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the upper edge of the rectangular collimator with respect to pixels in the image given as row. See C.8.7.3.1.1.
Collimator Lower Horizontal Edge	(0018,1708)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the lower edge of the rectangular collimator with respect to pixels in the image given as row. See C.8.7.3.1.1.
Center of Circular Collimator	(0018,1710)	1C	Required if Collimator Shape (0018,1700) is CIRCULAR. Location of the center of the circular collimator with respect to pixels in the image given as row and column. See C.8.7.3.1.1.
Radius of Circular Collimator	(0018,1712)	1C	Required if Collimator Shape (0018,1700) is CIRCULAR. Radius of the circular collimator with respect to pixels in the image given as a number of pixels along the row direction. See C.8.7.3.1.1.
Vertices of the Polygonal Collimator	(0018,1720)	1C	Required if Collimator Shape (0018,1700) 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 and all edges shall be non-intersecting except at the vertices.

178

Add new X-Ray 3D General macro

180 **C.8.21.3.1.3 X-Ray 3D General Positioner Movement Macro**

Table C.8.21.3.1.3-1 describes the X-Ray 3D General Positioner Movement Macro that specifies the

182 Attributes that describe the movement of a positioner during the acquisition of more than one projection.

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**Table C.8.21.3.1.3-1
X-RAY 3D GENERAL POSITIONER MOVEMENT MACRO**

Attribute Name	Tag	Type	Attribute Description
Primary Positioner Scan Arc	(0018,9508)	1C	Total amount of rotation of the primary positioner in degrees. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Primary Positioner Scan Start Angle	(0018,9510)	1C	Start position of the primary positioner in degrees. See C.8.7.5.1.2 or C.8.11.7, depending on modality and positioner type. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Primary Positioner Increment	(0018,9514)	1C	Nominal increment of the primary positioner angle in degrees. Positive values indicate moving from RAO to LAO position through the anterior, or right to vertical. See C.8.7.5.1.2 or C.8.11.7, depending on modality and positioner type. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Secondary Positioner Scan Arc	(0018,9509)	1C	Total amount of rotation of the secondary positioner in degrees. Required if present and consistent in the contributing SOP Instances.
Secondary Positioner Scan Start Angle	(0018,9511)	1C	Start position of the secondary positioner in degrees. See C.8.7.5.1.2 or C.8.11.7, depending on modality and positioner type. Required if present and consistent in the contributing SOP Instances.
Secondary Positioner Increment	(0018,9515)	1C	Nominal increment of the secondary positioner angle in degrees. Positive values indicate moving from CAU to CRA through the anterior, or from anterior to posterior. See C.8.7.5.1.2 or C.8.11.7, depending on modality and positioner type. Required if present and consistent in the contributing SOP Instances.

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186 **Amend the existing X-Ray 3D modules to use the new macros, and “unfactor” attributes that need to be different in the different IODs**

188 **C.8.21.3.2 X-Ray 3D Angiographic Acquisition Module**

This section describes the X-Ray 3D Angiographic Acquisition Module.

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**Table C.8.21.3.2-1
X-RAY 3D ANGIOGRAPHIC ACQUISITION MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Acquisition Sequence	(0018,9507)	1	Each item represents an acquisition context related to one or more reconstructions. The values of the Acquisition Index (0020,9518) attribute may be used as index to Items in this sequence. One or more Items may be present.
>Field of View Shape	(0018,1147)	1C	Shape of the Field of View in the referenced images. Enumerated Values: RECTANGLE ROUND HEXAGONAL Required if present and consistent in the contributing SOP Instances.
>X-Ray Receptor Type	(0018,9420)	1C	Identifies the type of X-Ray receptor used. Enumerated Values: IMG_INTENSIFIER DIGITAL_DETECTOR Required if present and consistent in the contributing SOP Instances.
>Include 'X-Ray 3D General Shared Acquisition Macro' Table C.8.215.3.1.1-1			
>Include 'Digital X-Ray Detector Macro' Table C.8-71b			
>Physical Detector Size	(0018,9429)	1C	Dimensions of the physical detector measured in mm as a row size followed by a column size. Required if present and consistent in the contributing SOP Instances.

>Position of Isocenter Projection	(0018,9430)	1C	<p>Position of the Isocenter measured in physical detector elements as a row offset followed by a column offset from the TLHC of a rectangle circumscribing the physical detector area.</p> <p>Required if Isocenter Reference System Sequence (0018,9462) is present.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
>Distance Source to Detector	(0018,1110)	1C	<p>Distance from source to receptor plane perpendicular to the receptor plane in mm or distance in mm from source to detector center on the chest wall line See C.8.11.7.1.1.</p> <p>Required if present and consistent in the contributing SOP Instances.</p> <p>Note: This value is traditionally referred to as Source Image Receptor Distance (SID).</p>
>Distance Source to Isocenter	(0018,9402)	1C	<p>Distance from source to isocenter in mm.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
>Focal Spot	(0018,1190)	1C	<p>Nominal focal spot size in mm used to acquire this image.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
>Filter Type	(0018,1160)	1C	<p>Type of filter(s) inserted into the X-Ray beam (e.g. wedges). <u>See Attribute Description in Section C.8.7.10 for Defined Terms.</u></p> <p>Defined Terms:</p> <p>—— STRIP</p> <p>—— WEDGE</p> <p>—— BUTTERFLY</p> <p>—— MULTIPLE</p> <p>—— NONE</p> <p>Required if present and consistent in the contributing SOP Instances.</p>

>Filter Material	(0018,7050)	1C	<p>The X-Ray absorbing material used in the filter. May be multi-valued). <u>See Attribute Description in Section C.8.7.10 for Defined Terms.</u></p> <p>Defined Terms:</p> <p>_____ MOLYBDENUM</p> <p>_____ ALUMINUM</p> <p>_____ COPPER</p> <p>_____ RHODIUM</p> <p>_____ NIOBIUM</p> <p>_____ EUROPIUM</p> <p>_____ LEAD</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
>Filter Thickness Minimum	(0018,7052)	1C	<p>The minimum thickness in mm of the X-Ray absorbing material used in the filters. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050)See Attribute Description in Section C.8.7.10.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
>Filter Thickness Maximum	(0018,7054)	1C	<p>The maximum thickness in mm of the X-Ray absorbing material used in the filters. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050)See Attribute Description in Section C.8.7.10.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
<u>>Include 'X-Ray 3D General Positioner Movement Macro' Table C.8.21.3.1.3-1</u>			
>Primary Positioner Scan Arc	(0018,9508)	1C	<p>Total amount of rotation of the primary positioner in degrees.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
>Primary Positioner Scan Start Angle	(0018,9510)	1C	<p>Start position of the primary positioner in degrees. See C.8.7.5.1.2.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>
>Primary Positioner Increment	(0018,9514)	1C	<p>Nominal increment of the primary positioner angle in degrees. Positive values indicate moving from RAO to LAO position through the anterior. See C.8.7.5.1.2.</p> <p>Required if present and consistent in the contributing SOP Instances.</p>

>Secondary Positioner Scan Arc	(0018,9509)	1C	Total amount of rotation of the secondary positioner in degrees. Required if present and consistent in the contributing SOP Instances.
>Secondary Positioner Scan Start Angle	(0018,9511)	1C	Start position of the secondary positioner in degrees. See C.8.7.5.1.2. Required if present and consistent in the contributing SOP Instances.
>Secondary Positioner Increment	(0018,9515)	1C	Nominal increment of the secondary positioner angle in degrees. Positive values indicate moving from CAU to CRA through the anterior. See C.8.7.5.1.2. Required if present and consistent in the contributing SOP Instances.
>Per Projection Acquisition Sequence	(0018,9538)	1C	Sequence containing detailed acquisition context of each individual projection used in this acquisition context. Zero or more items may be present. Required if present and consistent in the contributing SOP Instances.
>>Include 'X-Ray 3D General Acquisition Per Projection Acquisition Macro' Table C.8.215-2.3.1.2-1			
>>Positioner Isocenter Primary Angle	(0018,9463)	1C	Position of the X-Ray center beam for this projection in the isocenter reference system in the X direction (deg). See C.8.19.6.13.1.2 for further explanation. Required if present and consistent in the contributing SOP Instances.
>>Positioner Isocenter Secondary Angle	(0018,9464)	1C	Position of the X-Ray center beam for this projection in the isocenter reference system in the Z direction (deg). See C.8.19.6.13.1.2 for further explanation. Required if present and consistent in the contributing SOP Instances.
>>Positioner Isocenter Detector Rotation Angle	(0018,9465)	1C	Rotation of the X-Ray detector plane for this projection (deg). See C.8.19.6.13.1.2 for further explanation. Required if present and consistent in the contributing SOP Instances.

C.8.21.3.3 X-Ray 3D Craniofacial Acquisition Module

194 This section describes the X-Ray 3D Craniofacial Acquisition Module.

**Table C.8.21.3.3-1
X-RAY 3D CRANIOFACIAL ACQUISITION MODULE ATTRIBUTES**

196

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Acquisition Sequence	(0018,9507)	1	Each item represents a acquisition context related to a set of frames of SOP Instance defined by this IOD, The values of the Acquisition Index (0020,9518) attribute may be used as index to Items in this sequence. One or more Items may be present.
>Field of View Shape	(0018,1147)	1C	<u>Shape of the Field of View in the referenced images.</u> <u>Enumerated Values:</u> <u>RECTANGLE</u> <u>ROUND</u> <u>HEXAGONAL</u> <u>Required if present and consistent in the contributing SOP Instances.</u>
>X-Ray Receptor Type	(0018,9420)	1C	<u>Identifies the type of X-Ray receptor used.</u> <u>Enumerated Values:</u> <u>DIGITAL DETECTOR</u> <u>Required if present and consistent in the contributing SOP Instances.</u>
<i>>Include 'X-Ray 3D General Shared Acquisition Macro' Table C.8.215.3.1.1-1</i>			
<i>>Include 'Digital X-Ray Detector Macro' Table C.8-71b</i>			
>Per Projection Acquisition Sequence	(0018,9538)	1C	Sequence containing detailed acquisition context of each individual projection used in this acquisition context. Zero or more items may be present. Required if present and consistent in the contributing SOP Instances.
>>Include 'X-Ray 3D General Acquisition Per Projection Acquisition Macro' Table C.8.215-2.3.1.2-1			

198 **Amend the existing Mammography Image module**

C.8.11.7 Mammography Image Module

200 Table C.8.74 contains IOD Attributes that describe a Digital Mammography X-Ray Image including its acquisition and positioning.

202

**Table C.8-74
MAMMOGRAPHY IMAGE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...			
Breast Implant Present	(0028,1300)	3	Whether or not an breast implant is present. Enumerated Values: YES NO
Partial View	(0028,1350)	3	Indicates whether this image is a partial view, that is a subset of a single view of the breast. Enumerated Values: YES, NO If this Attribute is absent, then the image may or may not be a partial view. Note: This may occur when a breast is larger than the active area of the detector. If this Attribute is present, its value shall be NO if there is a View Modifier Code Sequence (0054,0222) Item of value (R-102D6, SNM3SRT , "Magnification") or (R-102D7, SNM3SRT , "Spot Compression"). Note: SRT is the preferred designator for SNOMED, but SNM3 is allowed for backward compatibility. See PS 3.16.
Partial View Description	(0028,1351)	3	Free text description of the portion of the breast captured in a partial view image. This Attribute shall not be present if there is a View Modifier Code Sequence (0054,0222) Item of value (R-102D6, SNM3SRT , "Magnification") or (R-102D7, SNM3SRT , "Spot Compression"). Note: SRT is the preferred designator for SNOMED, but SNM3 is allowed for backward compatibility. See PS 3.16.
Partial View Code Sequence	(0028,1352)	3	Sequence that describes the portion or section of the breast captured in a partial view image. One or two Items may be present. See C.8.11.7.1.3. If this Attribute is absent, then the image may or may not be a partial view. This Attribute shall not be present if there

			is a View Modifier Code Sequence (0054,0222) Item of value (R-102D6, SNM3SRT , "Magnification") or (R-102D7, SNM3SRT , "Spot Compression"). <u>Note: SRT is the preferred designator for SNOMED, but SNM3 is allowed for backward compatibility. See PS 3.16.</u>
...			

204

Add new sections to C.8 MODALITY SPECIFIC MODULES

206 **C.8.11.X Enhanced Mammography Series Module**

208 The Breast Tomosynthesis Image IOD uses the General Series module described in section C.7.3.1,
210 specialized by the Enhanced Mammography Series Module, to describe the DICOM Series Entity described in A.1.2.3, and to define what constitutes a Series for the context of a Breast Tomosynthesis device.

212 Table C.8-X specifies the Attributes that identify and describe general information about the Enhanced Mammography Series.

**Table C.8-X
ENHANCED MAMMOGRAPHY SERIES MODULE ATTRIBUTES**

214

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. Enumerated Values: MG See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). The Sequence shall have one Item. Required if the Modality Performed Procedure Step SOP Class or General Purpose Performed Procedure Step SOP Class is supported.
>Include SOP Instance Reference Macro Table 10-11			
Request Attributes Sequence	(0040,0275)	3	Sequence that contains attributes from the Imaging Service Request. The sequence may have one or more Items.
>Include Request Attributes Macro Table 10-9			For Reason for Requested Procedure Code Sequence (0040,100A) the Baseline Context IDs are 6051 and 6055. No Baseline Context IDs are

	<p><i>defined for other Attributes.</i></p> <p>Note: For example, Requested Procedure Code Sequence (0040,100A) may be used to convey whether the images in the Series were taken for screening or diagnostic purposes.</p>
--	---

216 **C.8.21.2.3 Breast Tomosynthesis Contributing Sources Module**

218 This section describes the Breast Tomosynthesis Contributing Sources Module. The attributes in this
 220 Module specify the overall characteristics of one or more source images that were used to create a Breast
 Tomosynthesis Image SOP Class instance. Table C.8.21.2.3-1 contains the IOD Attributes that describe
 Breast Tomosynthesis Contributing Sources.

222 Note: The intention of this module is to supply acquisition information without the need to have access to all the
 source projection images.

224

**Table C.8.21.2.3-1
BREAST TOMOSYNTHESIS CONTRIBUTING SOURCES MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Contributing Sources Sequence	(0018,9506)	1	A sequence that describes characteristics of the sources that are used to create a derived SOP Instance. One or more items shall be present.
>Include 'General Contributing Sources Macro' Table 10-13			
>Include 'Contributing Image Sources Macro' Table 10-14			
>Detector Type	(0018,7004)	1	The type of detector used to acquire this image. Defined Terms: DIRECT = X-Ray photoconductor SCINTILLATOR = Phosphor used STORAGE = Storage phosphor
>Detector ID	(0018,700A)	1	The ID or serial number of the detector used to acquire this image.
>Date of Last Detector Calibration	(0018,700C)	1	The date on which the detector used to acquire this image as identified in Detector ID (0018,700A) was last calibrated.
>Time of Last Detector Calibration	(0018,700E)	1	The time at which the detector used to acquire this image as identified in Detector ID (0018,700A) was last calibrated.
>Detector Element Spacing	(0018,7022)	1	Physical distance between the center of each detector element, specified by a numeric pair: row spacing value (delimiter) column spacing value in mm. See 10.7.1.3 for further explanation of the value order. Note: This may not be the same as the Imager Pixel Spacing (0018,1164), and should not be assumed to describe the stored image.

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C.8.21.3.4 Breast Tomosynthesis Acquisition Module

228 This section describes the Breast Tomosynthesis Acquisition Module.

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**Table C.8.21.3.4-1
BREAST TOMOSYNTHESIS ACQUISITION MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Acquisition Sequence	(0018, 9507)	1	Each Item represents an acquisition context related to one or more reconstructions. The values of the Acquisition Index (0020,9518) attribute may be used as index in this sequence. One or more Items shall be present.
>Field of View Shape	(0018,1147)	1	Shape of the Field of View in the source projection images. Enumerated Values: RECTANGLE
<i>>Include 'X-Ray 3D General Shared Acquisition Macro' Table C.8.21.3.1.1-1</i>			
<i>>Include 'X-Ray 3D General Positioner Movement Macro' Table C.8.21.3.1.3-1</i>			
>Distance Source to Detector	(0018,1110)	1	Distance in mm from source to detector center on the chest wall line. Notes: 1. This value is traditionally referred to as Source Image Distance (SID). 2. See C.8.11.7.1.1.
>Distance Source to Patient	(0018,1111)	1	Distance in mm from source to the bucky side that is closest to the Imaging Subject, as measured along the X-Ray beam vector. Notes: 1. This value is traditionally referred to as Source Object Distance (SOD). 2. See notes for this attribute in C.8.11.5 DX Positioning Module. 3. See C.8.11.7.1.1 for description of X-Ray beam vector.
>Estimated Radiographic Magnification Factor	(0018,1114)	1	Ratio of Source Image Receptor Distance (SID) over Source Object Distance (SOD).
>Anode Target Material	(0018,1191)	1	The primary material in the anode of the X-Ray source. Defined Terms: TUNGSTEN MOLYBDENUM RHODIUM

>Body Part Thickness	(0018,11A0)	1	The average thickness in mm of the body part examined when compressed, if compression has been applied during exposure.
>Exposure Control Mode	(0018,7060)	1	Type of exposure control. Defined Terms: MANUAL AUTOMATIC
>Exposure Control Mode Description	(0018,7062)	1	Text description of the mechanism of exposure control. May describe the number and type of exposure sensors or position of the sensitive area of the imaging detector.
>Half Value Layer	(0040,0314)	1	The thickness of Aluminum in mm required to reduce the X-Ray Output (0040,0312) by a factor of two. Note: This value may be a calibrated value rather than measured during the exposure.
>Focal Spot	(0018,1190)	1	Nominal focal spot size in mm used to acquire the projection images.
>Detector Binning	(0018,701A)	1C	Number of active detectors used to generate a single pixel. Specified as number of row detectors per pixel then column. Required if detector binning was applied to the projection images.
>Detector Temperature	(0018,7001)	1	Detector temperature during exposure in degrees Celsius.
>Filter Type	(0018,1160)	1	Type of filter(s) inserted into the X-Ray beam (e.g. wedges). See Attribute Description in Section C.8.7.10 for Defined Terms.
>Filter Material	(0018,7050)	1	The X-Ray absorbing material used in the filter. May be multi-valued. See Attribute Description in Section C.8.7.10 for Defined Terms.
>Filter Thickness Minimum	(0018,7052)	3	See Attribute Description in Section C.8.7.10.
>Filter Thickness Maximum	(0018,7054)	3	See Attribute Description in Section C.8.7.10.
>Per Projection Acquisition Sequence	(0018,9538)	1	Sequence containing detailed acquisition context of each individual projection used in this acquisition context. One or more items shall be present.
>>Include 'X-Ray 3D General Per Projection Acquisition Macro' Table C.8.21.3.1.2-1			

>>Positioner Primary Angle	(0018,1510)	1	Position in degrees of the X-Ray beam vector in the coronal anatomical plane as if the patient were standing where movement of the X-Ray source from right to vertical is positive, and vertical is zero.
>>Positioner Secondary Angle	(0018,1511)	1C	Position in degrees of the X-Ray beam vector in the sagittal anatomical plane as if the patient were standing where movement of the X-Ray source from anterior to posterior is positive, and vertical is zero. Required if secondary positioner was used during acquisition.
>>Exposure Time in ms	(0018,9328)	1	Duration of X-Ray exposure in milliseconds. See C.8.7.2.1.1.
>>Exposure in mAs	(0018,9332)	1	The exposure expressed in milliampereseconds, for example calculated from Exposure Time and X-ray Tube Current.
>>Relative X-ray Exposure	(0018,1405)	1	Indication of the applied dose, in manufacturer specific units. Notes: 1. This value is intended to provide a single location where manufacturer specific information can be found for annotation on a display or film, that has meaning to a knowledgeable observer. 2. This may be a calculated or measured value. Examples are the detector entrance dose (K_B), the CR sensitivity value (S), or the logarithmic median (lgM).
>>Organ Dose	(0040,0316)	3	Average organ dose value measured in dGy. Note: This may be an estimated value.
>>Entrance Dose in mGy	(0040,8302)	3	Average entrance dose value measured in mGy at the surface of the patient during the acquisition of this projection image. Note: This may be an estimated value based on assumptions about the patient's body size and habitus.

232 **C.8.21.6 Breast View Module**

Table C.8.21.6-1 contains IOD Attributes that describe the view of a Breast Tomosynthesis Image.

234

**Table C.8.21.6-1
BREAST VIEW MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
View Code Sequence	(0054,0220)	1	Sequence that describes the view of the patient anatomy in this image. One Item shall be present.
<i>>Include 'Code Sequence Macro' Table 8.8-1.</i>			<i>Enumerated Value for Context ID is 4014.</i>
>View Modifier Code Sequence	(0054,0222)	2	Sequence that provides modifiers for the view of the patient anatomy. Zero or more Items shall be present.
<i>>>Include 'Code Sequence Macro' Table 8.8-1.</i>			<i>Enumerated Value for Context ID is 4015.</i>
Breast Implant Present	(0028,1300)	1C	Whether or not a breast implant is present. Enumerated Values: YES NO Required if Modality (0008,0060) is MG. May be present otherwise.
Partial View	(0028,1350)	3	Indicates whether this image is a partial view, that is a subset of a single view of the breast. Enumerated Values: YES, NO If this Attribute is absent, then the image may or may not be a partial view. Note: This may occur when a breast is larger than the active area of the detector. If this Attribute is present, its value shall be NO if there is a View Modifier Code Sequence (0054,0222) Item of value (R-102D6, SRT, "Magnification") or (R-102D7, SRT, "Spot Compression").
Partial View Code Sequence	(0028,1352)	1C	Sequence that describes the portion or section of the breast captured in a partial view image. One or two Items shall be present. See C.8.11.7.1.3. Required if Partial View (0028,1350) is present with a value of YES.
<i>>Include 'Code Sequence Macro' (Table 8.8-1).</i>			<i>Defined Context ID is 4005.</i>

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Changes to NEMA Standards Publication PS 3.4-2008

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Digital Imaging and Communications in Medicine (DICOM)

Part 4: Service Class Specifications

248

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

B.5 STANDARD SOP CLASSES

250

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

SOP Class	SOP Class UID	IOD Specification (defined in PS 3.3)
Breast Tomosynthesis Image Storage	1.2.840.10008.5.1.4.1.1.13.1.3	

252

Add SOP Class to Table I.4-1

254 **I.4 MEDIA STORAGE SOP CLASSES**

256

**Table I.4-1
Media Storage Standard SOP Classes**

SOP Class	SOP Class UID	IOD Specification
Breast Tomosynthesis Image Storage	1.2.840.10008.5.1.4.1.1.13.1.3	IOD defined in PS 3.3

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Changes to NEMA Standards Publication PS 3.6-2008

Digital Imaging and Communications in Medicine (DICOM)

268

Part 6: Data Dictionary

Amend the following row in Section 6

Tag	Name	VR	VM
(0028,1300)	Breast Implant Present	CS	1

270

Add the following row to Table A-1

UID Value	UID Name	UID Type	Part
1.2.840.10008.5.1.4.1.1.13.1.3	Breast Tomosynthesis Image Storage	SOP Class	PS 3.4

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