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## **Digital Imaging and Communications in Medicine (DICOM)**

*Supplement 58: Enhanced CT Image Storage SOP Class*

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**Standard DICOM foreword – will remain unchanged in DICOM part 3 Foreword**

**DICOM Working Group 21 has prepared this Supplement according to the procedures of the DICOM Committee.**

85

## Foreword

The American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) formed a joint committee to develop a standard for Digital Imaging and Communication in Medicine (DICOM). This DICOM Standard was developed according to the NEMA procedures.

90 This Standard is developed in liaison with other standardization organizations including CEN TC251 in Europe and JIRA in Japan, with review also by other organizations including IEEE, HL7 and ANSI in the USA.

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.

95 This document is a Supplement to the DICOM Standard. It is an extension to Part 3, 4, 6 and 16 of the published DICOM Standard, which consists of the following parts:

- |     |         |                                  |
|-----|---------|----------------------------------|
| 100 | PS 3.3  | - Information Object Definitions |
|     | PS 3.4  | - Service Class Specifications   |
|     | PS 3.6  | - Data Dictionary                |
|     | PS 3.15 | - Security Profiles              |
|     | PS 3.16 | - Content Mapping Resource       |

105 These parts are related but independent documents. Their development level and approval status may differ. Additional parts may be added to this multi-part standard.

**Introduction – will not appear in the final standard**

## **INTRODUCTION**

110 The DICOM WG 21 has determined that it is necessary to create a new CT object to meet the  
needs of state of the art CT technology that has evolved substantially since the existing CT object  
was standardized in 1993.

### **I.1 LIMITATIONS OF THE CURRENT STANDARD**

115 It is not possible without the use of extensive collections of private elements to describe modern  
CT acquisition methods using the current standard; hence interoperability and advanced  
annotation are hampered by the current standard.

120 Furthermore, new applications such as cardiac CT, gated studies, perfusion CT, CT fluoroscopy,  
contrast tracking and post-processing are not supported by the current standard. Not only are  
technique attributes insufficient, but also the organization of increasingly large datasets as single  
frame objects is awkward, and limitations of the existing definitions of spatial and temporal  
attributes are apparent.

125 The WG 21 believes that adding new optional elements to the existing CT object would not be  
sufficient to meet the needs of modern CT applications.

### **I.2 SCOPE AND FIELD OF APPLICATION**

This Supplement describes the Enhanced Computed Tomography Storage SOP Class, which  
allows the CT Image generating system to store information on systems, which perform as a CT  
Storage SCP.

130 Due to practical considerations the present CT Image IOD will not be retired, however the use of  
the new IOD is encouraged.

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

This Supplement includes a number of revisions to existing Parts of DICOM:

- 135
1. Part 3 Addenda (Enhanced CT IOD)
  2. Part 4 Addenda (Enhanced CT Storage SOP Class)
  3. Part 6 Addenda (Extended Data Dictionary of CT Attributes)
  4. Part 15 Addenda ((New Digital Signature Module)
  5. Part 16 Addenda (New CID)

140 It is not proposed to add new services, messaging or encoding.

***Editor notes: This supplement assumes that the next CP's are Final Text:***

***CP 367 – Palette Color LUT for enhanced MR images***

***CP 381 – Defined Terms for Image Type in Enhanced MR***

***Some SNOMED Codes in CID 4031 are not correct and will be corrected by CP 426. The applicable codes are marked in the table.***

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**Changes to NEMA Standards Publication PS 3.3-2003**

**Digital Imaging and Communications in Medicine (DICOM)**

**Part 3: Information Object Definitions**

**Item #1: Add new reference in Section 2: Normative references**

160 **IEC 60601-2-44, Ed.2.1 Medical Electrical Equipment – Part 2-44: Particular Requirements for the Safety of X-Ray Equipment for Computed Tomography**

**Item #1a: Add in Section A.1.4, Table A.1-4**

**A.1.4 Overview of the Composite IOD Module Content**

165 Add the following columns to table A.1-1.

IODs Modules	Enh. CT
Patient	M
Specimen Identification	U
Clinical Trial Subject	U
General Study	M
Patient Study	U
Clinical Trial Study	U
General Series	M
CT Series	M
Clinical Trial Series	U
Frame Of Reference	M
Synchronization	C
General Equipment	M
Image Pixel	M
Enhanced Contrast/ Bolus	C
Multi-frame Functional Groups	M
Multi-frame Dimension	M
Cardiac Synchronization	C
Respiratory Synchronization	C
Supplemental Palette Color Lookup Table	C
Acquisition Context	M
Enhanced CT Image	M
Softcopy Presentation LUT	M
SOP Common	M



**Item #2: Add in the following new section in Annex A**

**A.X ENHANCED COMPUTED TOMOGRAPHY IMAGE INFORMATION OBJECT DEFINITION**

170

**A.X.1 Enhanced CT Image Information Object Definition**

**A.X.1.1 Enhanced CT Image IOD Description**

The Enhanced Computed Tomography (CT) Image Information Object Definition (IOD) specifies an image that has been created by a computed tomography imaging device.

175

**A.X.1.2 Enhanced CT Image IOD Entity-Relationship Model**

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model that directly reference the Enhanced CT Image IOD.

**A.X.1.3 Enhanced CT Image IOD Module Table**

**Table A.X-1  
ENHANCED CT IMAGE IOD MODULES**

180

<b>IE</b>	<b>Module</b>	<b>Reference</b>	<b>Usage</b>
Patient	Patient	C.7.1.1	M
	Specimen Identification	C.7.1.2	U
	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
	CT Series	C.8.X.1	M
	Clinical Trial Series	C.7.3.2	U
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
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.X	C – Required if contrast media was applied.
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Cardiac Synchronization	C.7.6.18.1	C – Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C – Required if respiratory synchronization was applied.

	Supplemental Palette Color Lookup Table	C.7.6.19	C – Required if Pixel Presentation (0008,9205) in the Enhanced CT Image Module equals COLOR or MIXED.
	Acquisition Context	C.7.6.14	M
	Enhanced CT Image	C.8.X.2	M
	Softcopy Presentation LUT	C.11.6	M
	SOP Common	C.12.1	M

#### A.X.1.3.1 Enhanced CT Image IOD Content Constraints

The General Image Module, Overlay Plane Module, Curve Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced CT Image.

- 185 Note: In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.
- 190 No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.
- Grayscale Softcopy Presentation State Storage Instances that are generated during acquisition may be referenced from the Image SOP Instance by using the Referenced Grayscale Presentation State Sequence in the Enhanced CT Image Module. See C.8.X.2.

#### 195 A.X.1.4 Enhanced CT Image Functional Group Macros

Table A.X-2 specifies the use of the Functional Group macros used in the Multi-frame Functional Group Module for the Enhanced CT Image IOD.

**Table A.X-2  
ENHANCED CT IMAGE FUNCTIONAL GROUP MACROS**

Function 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	C – Required if the image or frame has been planned on another image or frame, may be present otherwise.
Derivation Image	C.7.6.16.2.6	C – Required if the image or frame has been derived from another SOP Instance.

Cardiac Trigger	C.7.6.16.2.7	C – Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Frame Anatomy	C.7.6.16.2.8	M
Frame VOI LUT	C.7.6.16.2.10	U
Real World Value Mapping	C.7.6.16.2.11	U
Contrast/Bolus Usage	C.7.6.16.2.X	C – Required if Contrast/Bolus Agent Sequence (0018,0012) is used. May not be used as a Shared Functional Group
CT Frame Type	C.8.X.3.1	M
CT Acquisition Type	C.8.X.3.1a	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Acquisition Details	C.8.X.3.2	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Table Dynamics	C.8.X.3.3	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Position	C.8.X.3.3a	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise
CT Geometry	C.8.X.3.4	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Reconstruction	C.8.X.3.5	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE, may be present otherwise.
CT Exposure	C.8.X.3.6	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT X-ray Details	C.8.X.3.7	C – Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Pixel Value Transformation	C.8.X.3.8	M

**Item #3: Change and add the following sections of C.7**

**C.7 COMMON COMPOSITE IMAGE IOD MODULES**

...

**C.7.6.4 Contrast/Bolus Module**

205 Table C.7-12 specifies the Attributes that describe the contrast /bolus used in the acquisition of the Image.

**Table C.7-12  
CONTRAST/BOLUS MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...			
Contrast Flow Rate( <b>s</b> )	(0018,1046)	3	Rate(s) of injection(s) in milliliters/sec
Contrast Flow Duration( <b>s</b> )	(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).
...			

210 **C.7.6.16 Multi-frame Functional Groups Module**

Table C.7.6.16-1 specifies the attributes of the Multi-frame Functional Groups Module. This module is included in SOP instances even if there is only one frame in the instance.

**Table C.7.6.16-1  
MULTI-FRAME FUNCTIONAL GROUPS MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...			
Per-frame Functional Groups Sequence	(5200,9230)	1	Sequence that contains the Functional Group Macros corresponding to each frame of the Multi-frame Image. The first Item corresponds with the first frame, and so on. Each Item shall contain the same set of Functional Group Macros.  This Sequence shall contain the same number of Items as the number of frames in the Multi-frame image. See Section C.7.6.16.1.2 for further explanation.
<i>&gt;Include one or more Functional Group Macros.</i>			For each IOD that includes this module, a table is defined in which the permitted Functional Group Macros and their usage is specified.

<b><u>Instance Number</u></b>	<b><u>(0020,0013)</u></b>	<b><u>1</u></b>	<b><u>A number that identifies this instance. The value shall be the same for all SOP Instances of a Concatenation, and different for each separate Concatenation and for each SOP Instance not within a Concatenation in a series.</u></b>
<b><u>Content Date</u></b>	<b><u>(0008,0023)</u></b>	<b><u>1</u></b>	<b><u>The date the data creation was started.</u></b> Note: For instance, this is the date the pixel data is created, not the date the data is acquired.
<b><u>Content Time</u></b>	<b><u>(0008,0033)</u></b>	<b><u>1</u></b>	<b><u>The time the data creation was started.</u></b> Note: For instance, this is the time the pixel data is created, not the time the data is acquired.
<b><u>Number of Frames</u></b>	<b><u>(0028,0008)</u></b>	<b><u>1</u></b>	<b><u>Number of frames in a multi-frame image. See C.7.6.6.1.1 for further explanation.</u></b>
<b><u>Concatenation Frame Offset Number</u></b>	<b><u>(0020,9228)</u></b>	<b><u>1 C</u></b>	<b><u>Offset of the first frame in a multi-frame image of a concatenation. Logical frame numbers in a concatenation can be used across all its SOP instances. This offset can be applied to the implicit frame number to find the logical frame number in a concatenation. Required if Concatenation UID (0020,9161) is present.</u></b>
<b><u>Representative Frame Number</u></b>	<b><u>(0028,6010)</u></b>	<b><u>3</u></b>	<b><u>The frame number selected for use as a pictorial representation (e.g. icon) of the multi-frame Image.</u></b>
<b><u>Concatenation UID</u></b>	<b><u>(0020,9161)</u></b>	<b><u>1 C</u></b>	<b><u>Identifier of all SOP Instances that belong to the same concatenation. Required if a group of multi-frame image SOP Instances within a Series are part of a Concatenation.</u></b>
<b><u>In-concatenation Number</u></b>	<b><u>(0020,9162)</u></b>	<b><u>1 C</u></b>	<b><u>Identifier for one SOP Instance belonging to a concatenation. See C.7.6.16.2.2.4 for further specification. Required if Concatenation UID (0020,9161) is present.</u></b>

**C.7.6.16.2.1 Pixel Measures Macro**

Table C.7.6.16-2 specifies the attributes of the Pixel Measures Functional Group macro.

**Table C.7.6.16-2  
PIXEL MEASURES MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...			
>Pixel Spacing	(0028,0030)	1C	<p>Physical distance in the patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm.</p> <p><b>Note:</b> <u>In the case of CT images with an Acquisition Type (0018,9302) of CONSTANT ANGLE, the pixel spacing is that in a plane normal to the central ray of the diverging X-ray beam as it passes through the data collection center.</u></p> <p>Required if Volumetric Properties (0008,9206) is other than DISTORTED or SAMPLED. May be present otherwise.</p>
...			

**C.7.6.16.2.3 Plane Position Macro**

Table C.7.6.16-4 specifies the attributes of the Plane Position Functional Group macro.

**Table C.7.6.16-4  
PLANE POSITION MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Plane Position Sequence	(0020,9113)	1	Identifies the position of the plane of this frame. Only a single Item shall be permitted in this sequence.
>Image Position (Patient)	(0020,0032)	1C	<p>The x, y, and z coordinates of the upper left hand corner (center of the first voxel transmitted) of the frame, in mm. See C.7.6.2.1.1 and C.7.6.16.2.3.1 for further explanation.</p> <p><b>Note: In the case of CT images with an Acquisition Type (0018,9302) of CONSTANT ANGLE the image plane is defined to pass through the data collection center and be normal to the central ray of the diverging X-ray beam.</b></p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Volumetric Properties (0008,9206) of this frame is other than DISTORTED, may be present otherwise.</p>

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**C.7.6.16.2.8 Frame Anatomy Macro**

Table C.7.6.16-9 specifies the attributes of the Frame Anatomy Functional Group macro.

**Table C.7.6.16-9  
FRAME ANATOMY MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...			
>Anatomic Region Sequence	(0008,2218)	2	<p>Sequence that identifies the anatomic region of interest in this frame (i.e. external anatomy, surface anatomy, or general region of the body).</p> <p>Note: It is strongly recommended that this Attribute be sent with a value.</p> <p>See C.8.11.2.1.1 for further explanation. Only a single Item shall be permitted in this Sequence.</p>
>>Include 'Code Sequence Macro' Table 8.8-1			Defined Context ID is <b>40094030</b> .
...			

230

**C.7.6.16.2.10 Frame VOI LUT Macro**

Table C.7.6.16-11 specifies the attributes of the Frame VOI LUT Functional Group macro.

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

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
Frame VOI LUT Sequence	(0028,9132)	2	Window Center and Width values applied to the frame. Zero or one item may be included in this sequence.
>Window Center	(0028,1050)	1	Window Center for display. See C.11.2.1.2 for further explanation.
>Window Width	(0028,1051)	1	Window Width for display. See C.11.2.1.2 for further explanation.
<b>&gt;Window Center &amp; Width Explanation</b>	<b>(0028,105 5)</b>	<b>3</b>	<b>Explanation of the Window Center and Width.</b> <b>Defined Terms for CT:</b> <b>BRAIN</b> <b>SOFT TISSUE</b> <b>LUNG</b> <b>BONE</b>

235

**C.7.6.16.2.X Contrast/Bolus Usage Functional Group Macro**

Table C.7-X1 specifies the attributes of the Contrast/Bolus Usage Functional Group macro.

**Table C.7-X1  
CONTRAST/BOLUS USAGE FUNCTIONAL GROUP MACRO ATTRIBUTES**

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
Contrast/Bolus Usage Sequence	(0018,9341)	1	Contains the attributes describing the use of contrast for this frame. One or more Items shall be present in this sequence.
>Contrast/Bolus Agent Number	(0018,9337)	1	Identifying number corresponding to the agent described in the Enhanced Contrast/Bolus Module.
>Contrast/Bolus Agent Administered	(0018,9342)	1	The administration of the selected agent had begun by the time this frame was acquired.  Defined Terms:  YES NO



>Contrast/Bolus Agent Detected	(0018,9343)	2	<p>The selected agent was detected in the frame.</p> <p>Defined Terms: YES NO</p> <p>May only be zero length if the acquisition device is not capable of detecting the presence of this contrast agent in the frame.</p>
>Contrast/Bolus Agent Phase	(0018,9344)	2C	<p>Nominal phase of intravenous contrast administration.</p> <p>Defined terms: PRE_CONTRAST POST_CONTRAST IMMEDIATE DYNAMIC STEADY_STATE DELAYED ARTERIAL CAPILLARY VENOUS PORTAL_VENOUS</p> <p>Required if Contrast/Bolus Administration Route Sequence (0018,0014) for the Contrast/Bolus Agent Number (0018,9337) defined in the Contrast/Bolus Agent Sequence (0018,0012) is (SNM3, G-D101, "Intravenous route").</p>

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**C.7.6.X Enhanced Contrast/Bolus Module**

Table C.7-X2 specifies the Attributes that describe the contrast/bolus used in the acquisition of the Image.

**Table C.7-X2  
ENHANCED CONTRAST/BOLUS MODULE ATTRIBUTES**

245

Attribute Name	Tag	Type	Attribute Description
Contrast/Bolus Agent Sequence	(0018,0012)	1	Sequence that identifies one or more contrast agents administered prior to or during the acquisition. Shall contain one or more Items.
>Include 'Code Sequence Macro' Table 8.8-1		<i>Baseline Context ID is 12.</i>	
>Contrast/Bolus Agent Number	(0018,9337)	1	Identifying number, unique within this SOP Instance, of the agent administered. Used to reference this particular agent from the Contrast/Bolus Functional Group Macro.

>Contrast/Bolus Administration Route Sequence	(0018,0014)	1	Sequence that identifies the route of administration of contrast agent. Shall contain exactly one Item.
>>Include 'Code Sequence Macro' Table 8.8-1		<i>Baseline Context ID is 11.</i>	
>Contrast/Bolus Ingredient Code Sequence	(0018,9338)	2	Active ingredient of agent. Zero or more Items may be included in the Sequence.
>>Include 'Code Sequence Macro' Table 8.8-1		<i>Baseline Context ID is 13.</i>	
>Contrast/Bolus Volume	(0018,1041)	2	Total volume administered in milliliters of diluted contrast agent.
>Contrast/Bolus Ingredient Concentration	(0018,1049)	2	Milligrams of active ingredient per milliliter of agent.
>Contrast Administration Profile Sequence	(0018,9340)	3	Sequence that describes one or more phases of contrast administered. If present, shall contain one or more Items.
>>Contrast/Bolus Volume	(0018,1041)	2	Volume administered during this phase in milliliters of diluted contrast agent.
>>Contrast/Bolus Start Time	(0018,1042)	3	Time of start of administration.
>>Contrast/Bolus Stop Time	(0018,1043)	3	Time of end of administration.
>>Contrast Flow Rate	(0018,1046)	3	Rate of administration in milliliters/sec. Only a single value shall be present.
>>Contrast Flow Duration	(0018,1047)	3	Duration of injection in seconds. Only a single value shall be present.

Item #4: Change the following sections of C.8

**C.8 MODALITY SPECIFIC MODULES**

...

250 **C.8.13.1 Enhanced MR Image Module**

...

**Table C.8.13-1  
ENHANCED MR IMAGE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
<i>Include 'MR Image and Spectroscopy Instance Macro' Table C.8.13-32</i>			
<b>Image Type</b>	<b>(0008,0008)</b>	<b>1</b>	<b>Image characteristics. See C.8.Y.1 and C.8.13.3.1.1.</b>
<i>Include Common CT/MR Image Description Macro' Table C.8.Y.2-1</i>			
<i>Include 'MR Image Description Macro' Table C.8.13-4</i>			<del>The Frame Type (0008,9007) attribute shall not be used.</del>
...	...	...	...

255 **C.8.13.2 MR Image and Spectroscopy Instance Macro**

Table C.8.13-3 specifies the common attributes Enhanced MR Image Module and MR Spectroscopy Module.

**Table C.8.13-3  
MR IMAGE AND SPECTROSCOPY INSTANCE MACRO**

Attribute Name	Tag	Type	Attribute Description
<del>Instance Number</del>	<del>(0020,0013)</del>	<del>1</del>	<del>A number that identifies this instance. The value shall be the same for all SOP Instances of a Concatenation, and different for each separate Concatenation and for each SOP Instance not within a Concatenation in a series.</del>
<del>Content Date</del>	<del>(0008,0023)</del>	<del>1</del>	<del>The date the data creation was started.</del>
<del>Content Time</del>	<del>(0008,0033)</del>	<del>1</del>	<del>The time the data creation was started.</del>
...			
<del>Number of Frames</del>	<del>(0028,0008)</del>	<del>1</del>	<del>Number of frames in a multi-frame image. See C.7.6.6.1.1 for further explanation.</del>

<del>Concatenation Frame Offset Number</del>	<del>{0020,9228}</del>	<del>1-C</del>	<del>Offset of the first frame in a multi-frame image of a concatenation. Logical frame numbers in a concatenation can be used across all its SOP instances. This offset can be applied to the implicit frame number to find the logical frame number in a concatenation. Required if Concatenation UID (0020,9161) is present.</del>
<del>Representative Frame Number</del>	<del>{0028,6010}</del>	<del>3</del>	<del>The frame number selected for use as a pictorial representation (e.g. icon) of the multi-frame image.</del>
<del>Concatenation UID</del>	<del>{0020,9161}</del>	<del>1-C</del>	<del>Identifier of all SOP instances that belong to the same concatenation. Required if a group of multi-frame image SOP instances within a Series are part of a Concatenation.</del>
<del>In-concatenation Number</del>	<del>{0020,9162}</del>	<del>1-C</del>	<del>Identifier for one SOP instance belonging to a concatenation. See C.7.6.16.2.2.4 for further specification. Required if Concatenation UID (0020,9161) is present.</del>
<del>In-concatenation Total Number</del>	<del>{0020,9163}</del>	<del>3</del>	<del>The number of SOP instances sharing the same Concatenation UID.</del>
<del>...</del>	<del>...</del>	<del>...</del>	<del>...</del>

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...

### C.8.13.3 MR Image Description Macro

This section describes the MR Image Description Macro.

Table C.8.13-4 specifies the attributes of the MR Image Description Macro.

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**Table C.8.13-4  
MR IMAGE DESCRIPTION MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
<del>Image Type</del>	<del>{0008,0008}</del>	<del>1</del>	<del>Image identification characteristics. See C.8.13.3.1.1 for specialization.</del>

<del>Frame Type</del>	<del>(0008,9007 )</del>	<del>1</del>	<del>Type of Frame. A multi-valued attribute analogous to the Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of the Image Type (0008,0008) attribute, except that the value MIXED is not allowed. See section C.8.13.3.1.1 for further description.</del>
<del>Pixel Presentation</del>	<del>(0008,9205 )</del>	<del>1</del>	<del>Indication of the presence or absence of color information that may be used during rendering. See C.8.13.3.1.2 for a description and Enumerated Values.</del>
<del>Volumetric Properties</del>	<del>(0008,9206 )</del>	<del>1</del>	<del>Indication if geometric manipulations are possible with frames in the SOP Instance. See C.8.13.3.1.3 for a description and Enumerated Values.</del>
<del>Volume Based Calculation Technique</del>	<del>(0008,9207 )</del>	<del>1</del>	<del>Method used for volume calculations with frames in the SOP Instance. See C.8.13.3.1.4 for a description and Defined Terms.</del>
Complex Image Component	(0008,9208)	1	Representation of complex data of frames in the SOP Instance. See C.8.13.3.1.5 for a description and Defined Terms.
Acquisition Contrast	(0008,9209)	1	Indication of acquisition contrast used with frames in the SOP Instance. See C.8.13.3.1.6 for a description and Defined Terms.

### C.8.13.3.1 MR Image Description Attribute Description

#### C.8.13.3.1.1 Image Type and Frame Type

270 ... common stuff moved to C.8.Y.1 ... attribute invocation moved to C.8.13.1 (Image Type) and C.8.13.5.1 (Frame Type).

The Image Type (0008,0008) and Frame Type (0008,9007) are not included in this Macro but one or the other is always included in the Module or Macro that invokes this Macro, and they are therefore described here.

275 In addition to the requirements specified in C.8.Y.1 Image Type and Frame Type, the following additional requirements and Defined Terms are specified.

#### C.8.13.3.1.1.1 Pixel Data Characteristics

... moved ... replace all text with the following ...

280 Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in C.8.Y.1.1. No additional requirements or Defined Terms.

**C.8.13.3.1.1.2 Patient Examination Characteristics**

*... moved ... replace all text with the following ...*

**Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in C.8.Y.1.2. No additional requirements or Defined Terms.**

285 **C.8.13.3.1.1.3 Image Flavor**

~~Value 3 is an overall representation of the image type. This value may be a summary of several other attributes or a duplication of one of the other attributes to indicate the most important aspect of this image. Value 3 Image Flavor is to be used with Value 4 Derived Pixel Contrast to indicate the nature of the image set.~~

~~Note: For example Value 3 = DIFFUSION together with Value 4 = NONE indicates that the image set was originally collected for DIFFUSION.  
If Value 3 = DIFFUSION together with Value 4 = DIFFUSION this indicates that the object contains DIFFUSION weighted post processed images.~~

295 ~~Value 3 of Image Type (0008,0008) shall not be zero length.~~

~~Value 3 of Frame Type (0008,9007) may have the same value as found in Value 3 of Image Type (0008,0008), or may have a different value or may be of zero length.~~

300 ~~The attribute value may not be MIXED as this value needs to be a summary of the primary purpose of the images, whether the frames have the same value or not.~~

**Table C.8.13-7 specifies the Defined Terms for MR additional to those defined in C.8.Y.1.3 for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007).**

305

**Table C.8.13-7  
MR-SPECIFIC IMAGE TYPE AND FRAME TYPE VALUE 3**

<b>Defined Term Name</b>	<b>Defined Term Description</b>
ANGIO_TIME	Angio time acquisition (peripheral vascular/carotid)
METABOLITE_MAP	Metabolite Maps from spectroscopy data
CINE	Cardiac CINE
DIFFUSION	Collected to show diffusion effects.
FLOW_ENCODED	Flow Encoded
FLUID_ATTENUATED	Fluid Attenuated T2 weighted
FMRI	Collected for functional imaging calculations.
<b>LOCALIZER</b>	<del>Collected for the purpose of planning other images.</del>
MAX_IP	Maximum Intensity Projection
MIN_IP	Minimum Intensity Projection
M_MODE	Image line over time
<b>MOTION</b>	<del>Collected for looking at body motion</del>

METABOLITE_MAP	Metabolite Maps from spectroscopy data
MULTIECHO	Multiple echoes with different contrast weighting (e.g. proton density and T2 weighted)
<b>PERFUSION</b>	<b>Collected for the purposes of perfusion calculations.</b>
STIR	Short Tau Inversion Recovery
STRESS	Cardiac stress image set
TAGGING	Images with superposition of thin saturation bands
TEMPERATURE	Images record temperature
T1	T1 weighted
T2	T2 weighted
T2_STAR	T2* weighted
TOF	Time Of Flight weighted
VELOCITY	Velocity encoded

**C.8.13.3.1.1.4 Derived Pixel Contrast**

310 ~~Value 4 shall be used to indicate derived pixel contrast — generally, contrast created by combining or processing images with the same geometry. Value 4 shall have a value of NONE when Value 1 is ORIGINAL.~~

~~Note: If more than one of the following derived types is applicable, then it is up to the generating application to specify the value that best characterizes the derived image.~~

315 ~~Value 4 of Image Type (0008,0008) and Value 4 of Frame Type (0008,9007) shall not be zero length.~~

~~Table C.8.13-8 specifies the Defined Terms for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007).~~

320 ~~Table C.8.13-8 specifies the Defined Terms for MR additional to those defined in C.8.Y.1.4 for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007).~~

**Table C.8.13-8  
MR-SPECIFIC IMAGE TYPE AND FRAME TYPE VALUE 4**

Defined Term Name	Defined Term Description
ADC	Apparent Diffusion Coefficient
<b>ADDITION</b>	<b>Created through Pixel by pixel addition operation</b>
DIFFUSION	Diffusion weighted
DIFFUSION_ANISO	Diffusion Anisotropy
DIFFUSION_ATTNTD	Diffusion Attenuated. Derived by removing the T2 contributions from a Diffusion Weighted image.

<b>DIVISION</b>	<del>Created through Pixel by pixel division operation</del>
<b>MASKED</b>	<del>Created through Pixel by pixel masking operation</del>
<b>MAXIMUM</b>	<del>Created through Pixel by Pixel Maximum operation</del>
<b>MEAN</b>	<del>Created through Pixel by pixel mean operation</del>
METABOLITE_MAP	Metabolite Maps from spectroscopy data
<b>MINIMUM</b>	<del>Created through Pixel by Pixel Minimum operation</del>
<b>MTT</b>	<del>Mean Transit Time</del>
<b>MULTIPLICATION</b>	<del>Created through Pixel by pixel multiplication operation</del>
NEI	Created through Negative Enhancement Integral operation
<b>RCBF</b>	<del>Regional Cerebral Blood Flow (rCBF)</del>
<b>RCBV</b>	<del>Regional Cerebral Blood Volume (rCBV)</del>
R_COEFFICIENT	R-Coefficient Map (fMRI)
RHO	Proton Density map
SCM	Signal Change Map
SNR_MAP	Signal to Noise Map
<b>STD_DEVIATION</b>	<del>Standard Deviation</del>
<b>SUBTRACTION</b>	<del>Created through Pixel by pixel subtraction operation</del>
T1_MAP	T1 Map
T2_STAR_MAP	T2* Map
T2_MAP	T2 Map
TCS	Time Course of Signal
TEMPERATURE	Temperature encoded
<b>T_TEST</b>	<del>Student's T-Test</del>
<b>TTP</b>	<del>Time To Peak map</del>
VELOCITY	Velocity encoded
<b>Z_SCORE</b>	<del>Z-Score Map</del>
<b>NONE</b>	<del>Not a calculated image</del>
<b>MIXED</b>	<del>Used only as value in Image Type (0008,0008) if frames within the image SOP Instance contain different values for value 4 in their Frame Type (0008,9007) attribute.</del>

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*Delete C.8.13.3.1.2 Pixel Presentation... moved to C.8.Y.2.1.1 and amended ...*

**See C.8.Y.2.1. No additional requirements or Defined Terms.**

*Delete C.8.13.3.1.2.1 Supplemental Palette Color LUTs... moved to C.8.Y.2.1.1.1...*

**See C.8.Y.2.1.1. No additional requirements or Defined Terms.**



*Delete C.8.13.3.1.3 Volumetric Properties... moved to C.8.Y.2.1.2 and amended ...*

330

**See C.8.Y.2.1.2. No additional requirements or Defined Terms.**

*C.8.13.3.1.4 Volume Based Calculation Technique Attribute... moved to C.8.Y.2.1.3 ...*

**See C.8.Y.2.1.3. No additional requirements or Defined Terms.**

### C.8.13.3.1.5 Complex Image Component

335

The value of the Complex Image Component attribute (0008,9208) shall be used to indicate which component of the complex representation of the signal is represented in the pixel data.

Table C.8.13-12 specifies the Defined Terms for Complex Image Component attribute (0008,9208).

**Table C.8.13-12  
COMPLEX IMAGE COMPONENT ATTRIBUTE VALUES**

Defined Term Name	Defined Term Description
MAGNITUDE	The magnitude component of the complex image data.
PHASE	The phase component of the complex image data.
REAL	The real component of the complex image data.
IMAGINARY	The imaginary component of the complex image data.
MIXED	Used only as a value in Complex Image Component (0008,9208) in the Enhanced MR Image Module <del>or MR Spectroscopy Module</del> if frames within the image SOP Instance contain different values for the Complex Image Component attribute in the MR Frame Type Functional Group <del>or MR Spectroscopy Frame Type Functional Group</del> .

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### C.8.13.3.1.6 Acquisition Contrast

Table C.8.13-13 specifies the Defined Terms for Acquisition Contrast attribute (0008,9209).

**Table C.8.13-13  
ACQUISITION CONTRAST VALUES**

Defined Term Name	Defined Term Description
DIFFUSION	Diffusion weighted contrast
FLOW_ENCODED	Flow Encoded contrast
FLUID_ATTENUATED	Fluid Attenuated T2 weighted contrast
PERFUSION	Perfusion weighted contrast
PROTON_DENSITY	Proton Density weighted contrast
STIR	Short Tau Inversion Recovery
TAGGING	Superposition of thin saturation bands onto image
T1	T1 weighted contrast
T2	T2 weighted contrast
T2_STAR	T2* weighted contrast

TOF	Time Of Flight weighted contrast
UNKNOWN	Value should be UNKNOWN if acquisition contrasts were combined resulting in an unknown contrast. Also this value should be used when the contrast is not known.
MIXED	Used only as a value in Acquisition Contrast (0008,9209) attribute in the Enhanced MR Image Type Module <del>or MR Spectroscopy Module</del> if frames within the image SOP Instance contain different values for the Acquisition Contrast attribute in the MR Frame Type Functional Group <del>or MR Spectroscopy Frame Type Functional Group</del> .

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### C.8.13.5.1 MR Image Frame Type Macro

Table C.8.13-15 specifies the attributes of the MR Image Frame Type Functional Group macro.

**Table C.8.13-15  
MR IMAGE FRAME TYPE MACRO ATTRIBUTES**

350

Attribute Name	Tag	Type	Attribute Description
MR Image Frame Type Sequence	(0018,9226)	1	Identifies the characteristics of this frame. Only a single Item shall be permitted in this sequence.
<u>&gt;Frame Type</u>	<u>(0008,9007)</u>	<u>1</u>	<u>Type of Frame. A multi-valued attribute analogous to the Image Type (0008,0008).</u> <u>Enumerated Values and Defined Terms are the same as those for the four values of the Image Type (0008,0008) attribute, except that the value MIXED is not allowed.</u> <u>See C.8.Y.1 and C.8.13.3.1.1.</u>
<u>&gt;Include Common CT/MR Image Description Macro' Table C.8.Y.2-1</u>			
<u>&gt;Include 'MR Image Description Macro' Table C.8.13-4</u>			<u>The Image Type (0008,0008) attribute shall not be used.</u>

...

**C.8.14.1 MR Spectroscopy Module**

Table C.8.14-1 specifies the attributes of the MR Spectroscopy Module.

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**Table C.8.14-1  
MR SPECTROSCOPY MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
<i>Include 'MR Image and Spectroscopy Instance Macro' Table C.8.X-3</i>			
<b>Image Type</b>	<b>(0008,0008)</b>	<b>1</b>	<b>Spectroscopy data characteristics. See C.8.14.5.1.1.</b>
<i>Include 'MR-<del>Image Spectroscopy</del> Description Macro' Table <del>C.8.13-4</del> C.8.14-6</i>			<del>The Frame Type (0008,9007) attribute and Pixel Presentation (0008,9205) shall not be used.</del>
...	...	...	...

...

**C.8.14.3.1 MR Spectroscopy Frame Type Macro**

360

Table C.8.14-3 specifies the attributes of the MR Spectroscopy Frame Type Functional Group macro.

This Functional Group Macro may only be part of the Per-frame Functional Groups Sequence (0008,9124) attribute.

**Table C.8.14-3  
MR SPECTROSCOPY FRAME TYPE MACRO ATTRIBUTES**

365

Attribute Name	Tag	Type	Attribute Description
MR Spectroscopy Frame Type Sequence	(0018,9227)	1	Identifies sequence containing Frame Type Attributes. Only a single Item shall be permitted in this sequence.
<b>&gt;Frame Type</b>	<b>(0008,9007)</b>	<b>1</b>	<b>Spectroscopy data characteristics. See C.8.14.5.1.1.</b>
<i>Include 'MR-<del>Image Spectroscopy</del> Description Macro' Table <del>C.8.13-4</del> C.8.14-6</i>			<del>The Image Type (0008,0008) attribute and Pixel Presentation (0008,9205) attribute shall not be used.</del>

...

**C.8.14.5 MR Spectroscopy Description Macro**

Table C.8.14-6 specifies the attributes that describe the Spectroscopy.

370

**Table C. 8.14-6  
MR SPECTROSCOPY DESCRIPTION MACRO ATTRIBUTES**

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
Volumetric Properties	(0008,9206)	1	Indication if geometric manipulations are possible with frames in the SOP Instance. See C.8.14.5.1.2 for a description and Enumerated Values.
Volume Based Calculation Technique	(0008,9207)	1	Method used for volume calculations with frames in the SOP Instance. See C.8.14.5.1.3 for a description and Defined Terms.
Complex Image Component	(0008,9208)	1	Representation of complex data of frames in the SOP Instance. See C.8.14.5.1.4 for a description and Defined Terms.
Acquisition Contrast	(0008,9209)	1	Indication of acquisition contrast used with frames in the SOP Instance. See C.8.14.5.1.5 for a description and Defined Terms.

**C.8.14.5.1 MR Spectroscopy Description Attribute Description**

**C.8.14.5.1.1 Image Type and Frame Type**

375 The Image Type (0008,0008) and Frame Type (0008,9007) are not included in this Macro but one or the other is always included in the Module or Macro that invokes this Macro, and they are therefore described here.

In addition to the requirements specified in C.8.Y.1 Image Type and Frame Type, the following additional requirements and Defined Terms are specified.

380 **C.8.14.5.1.1.1 Pixel Data Characteristics**

See C.8.Y.1.1. No additional requirements or Defined Terms.

**C.8.14.5.1.1.2 Patient Examination Characteristics**

See C.8.Y.1.2. No additional requirements or Defined Terms.

**C.8.14.5.1.1.3 Image Flavor**

385 See C.8.Y.1.3 for requirements, but not Defined Terms.

Table C.8.14-7 specifies the Defined Terms for MR Spectroscopy for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007).

**Table C.8.14-7  
MR SPECTROSCOPY IMAGE TYPE AND FRAME TYPE VALUE 3**

Defined Term Name	Defined Term Description
SPECTROSCOPY	Spectroscopy

390

**C.8.14.5.1.1.4 Derived Pixel Contrast**

See C.8.Y.1.4 for requirements, but not Defined Terms.

Table C.8.14-8 specifies the Defined Terms for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007).

**Table C.8.14-8  
MR SPECTROSCOPY IMAGE TYPE AND FRAME TYPE VALUE 4**

Defined Term Name	Defined Term Description
ADDITION	Created through point by point addition operation
DIVISION	Created through point by point division operation
MAXIMUM	Created through point by point maximum operation
MEAN	Created through point by point mean operation
MINIMUM	Created through point by point minimum operation
MULTIPLICATION	Created through point by point multiplication operation
STD_DEVIATION	Standard Deviation
SUBTRACTION	Created through point by point subtraction operation
NONE	Not calculated
MIXED	Used only as value in Image Type (0008,0008) if frames within the spectroscopy SOP Instance contain different values for value 4 in their Frame Type (0008,9007) attribute.

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**C.8.14.5.1.2 Volumetric Properties**

See C.8.Y.2.1.2. No additional requirements or Defined Terms.

**C.8.14.5.1.3 Volume Based Calculation Technique Attribute**

See C.8.Y.2.1.3 for requirements, but not Defined Terms.

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Table C.8.14-9 specifies the Defined Terms for the Volume Based Calculation Technique (0008,9207) attribute.

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**Table C.8.14-9  
VOLUME BASED CALCULATION TECHNIQUE ATTRIBUTE VALUES**

Defined Term Name	Defined Term Description
MAX_IP	Maximum Intensity Projection
MIN_IP	Minimum Intensity Projection
NONE	Pixels not derived geometrically
MIXED	Used only as a value in Volume Based Calculation Technique (0008,9207) attribute in the MR Spectroscopy Module if frames within the image SOP Instance contain different terms for the Volume Based Calculation Technique attribute in MR Spectroscopy Frame Type Functional Group.

**C.8.14.5.1.4 Complex Image Component**

The value of the Complex Image Component attribute (0008,9208) shall be used to indicate which component of the complex representation of the signal is represented in the spectroscopy data.

410

Table C.8.14-10 specifies the Defined Terms for Complex Image Component attribute (0008,9208).

**Table C.8.14-10  
COMPLEX IMAGE COMPONENT ATTRIBUTE VALUES**

Defined Term Name	Defined Term Description
MAGNITUDE	The magnitude component of the complex spectroscopy data.
PHASE	The phase component of the complex spectroscopy data.
REAL	The real component of the complex spectroscopy data.
IMAGINARY	The imaginary component of the complex spectroscopy data.
COMPLEX	The real and imaginary components of the complex spectroscopy data
MIXED	Used only as a value in Complex Image Component (0008,9208) in the MR Spectroscopy Module if frames within the image SOP Instance contain different values for the Complex Image Component attribute in the MR Spectroscopy Frame Type Functional Group.

415

**C.8.14.5.1.5 Acquisition Contrast**

Table C.8.14-11 specifies the Defined Terms for Acquisition Contrast attribute (0008,9209).

**Table C.8.14-11  
ACQUISITION CONTRAST VALUES**

Defined Term Name	Defined Term Description
PROTON_DENSITY	Proton Density weighted contrast
T1	T1 weighted contrast
T2	T2 weighted contrast
UNKNOWN	Value should be UNKNOWN if acquisition contrasts were combined resulting in an unknown contrast. Also this value should be used when the contrast is not known.
MIXED	Used only as a value in Acquisition Contrast (0008,9209) attribute in the MR Spectroscopy Module if frames within the SOP Instance contain different values for the Acquisition Contrast attribute in the MR Spectroscopy Frame Type Functional Group.

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**C.8.X Enhanced CT Image**

This section describes the specific modules for the Enhanced CT Image IOD.

**C.8.X.1 CT Series Module**

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The CT IODs use the General Series module described in section C.7.3.1, specialized by the CT Series Module, to describe the DICOM Series Entity described in A.X, and to define what constitutes a Series for the context of CT device.

Table C.8-X1-1 specifies the Attributes that identify and describe general information about the CT Series.

430

**Table C.8-X1-1  
CT 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. Enumerated Values: CT 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 or Study Component SOP Instance). The Sequence shall have one Item.  Required if the Modality Performed Procedure Step SOP Class , General Purpose Performed Procedure Step SOP Class or Study Component SOP Class is supported.
>Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.

### C.8.X.2 Enhanced CT Image Module

435 This section describes the Enhanced CT Image Module. Table C.8-X.1 specifies the attributes of the Enhanced CT Image Module.

**Table C.8-X.1  
ENHANCED CT IMAGE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image characteristics. See sections C.8.Y.1 and C.8.X.2.1.1.
<i>Include Common CT/MR Image Description Macro' Table C.8.Y.2-1</i>			
Acquisition Number	(0020,0012)	3	A number identifying the single continuous gathering of data over a period of time that resulted in this image.
Acquisition Datetime	(0008,002A)	1C	The date and time that the acquisition of data started.  Notes: 1. The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800) .  2. See C.7.6.16.2.2.1 for an overview of all acquisition related timing attributes.  Required if Image Type (0008,0008) Value 1 of this frame is ORIGINAL or MIXED, may be present otherwise.



Acquisition Duration	(0018,9073)	2C	The time in seconds needed to complete the acquisition of data. See C.7.6.16.2.2.1 for further explanation.  Required if Image Type (0008,0008) Value 1 of this frame is ORIGINAL or MIXED, may be present otherwise.
Referenced Raw Data Sequence	(0008,9121)	3	A sequence that identifies the set of Raw Data SOP Class/Instance pairs of the Raw data that were used to derive this Image.  One or more Items may be included in this Sequence.
<i>&gt;Include 'SOP Instance Reference Macro' Table C.17-3</i>			
Referenced Waveform Sequence	(0008,113A)	3	References to waveforms acquired in conjunction with this image. These Waveforms may or may not be temporally synchronized with this image.  One or more Items may be included in this sequence.
<i>&gt;Include 'SOP Instance Reference Macro' Table C.17-3</i>			
Referenced Image Evidence Sequence	(0008,9092)	1C	Full set of Composite SOP Instances referring to image SOP Instances inside the frames of this Enhanced CT Image SOP Instance. See C.8.13.2.1.2 for further explanation.  One or more Items may be included in this sequence.  Required if the Referenced Image Sequence (0008,1140) is present.
<i>&gt;Include 'SOP Instance Reference Macro' Table C.17-3</i>			
Source Image Evidence Sequence	(0008,9154)	1C	Full set of Composite SOP Instances used as source image SOP Instances inside the frames of this Enhanced CT Image SOP Instance. See C.8.13.2.1.2 for further explanation.  One or more Items may be included in this sequence.  Required if the Source Image Sequence (0008,2112) is present.
<i>&gt;Include 'SOP Instance Reference Macro' Table C.17-3</i>			

Referenced Grayscale Presentation State Sequence	(0008,9237)	1C	<p>References to Grayscale Presentation State instances acquired in conjunction with this instance.</p> <p>Note: May only be used to reference Presentation States belonging to the acquired data and not to reference Presentation States generated subsequently such as during interpretation.</p> <p>One or more Items may be included in this sequence.</p> <p>Required if Presentation State is generated during acquisition, shall not be present otherwise.</p>
<i>&gt;Include 'SOP Instance Reference Macro' Table C.17-3</i>			
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. This value shall be 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Value: MONOCHROME2. See C.7.6.3.1.2 for definition of this term.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. This value shall be 16.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. This value shall be 12 or16.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Content Qualification	(0018,9004)	1	Content Qualification Indicator Enumerated Values: PRODUCT RESEARCH SERVICE See C.8.13.2.1.1 for further explanation.
Image Comments	(0020,4000)	3	User-defined comments about the image

Lossy Image Compression	(0028,2110)	1	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 for further explanation.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image.  See C.7.6.1.1.5 for further explanation.  May be multivalued if successive lossy compression steps have been applied. Note: For example, a compression ratio of 30:1 would be described in this Attribute with a single value of 30.
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image.
> Image Pixel Module			See Sec. C.7.6.1.1.6 for further explanation.

**C.8.X.2.1 CT Image Description Attribute Description**

440 **C.8.X.2.1.1 Image Type and Frame Type**

In addition to the requirements specified in C.8.Y.1 Image Type and Frame Type, the following additional requirements and Defined Terms are specified.

These requirements and Defined Terms are also applicable to Frame Type (0008,9007).

**C.8.X.2.1.1.1 Pixel Data Characteristics**

445 No additional requirements or Defined Terms.

**C.8.X.2.1.1.2 Patient Examination Characteristics**

No additional requirements or Defined Terms.

### C.8.X.2.1.1.3 Image Flavor

450 Table C.8.X.2.1.1.3-1 specifies the Defined Terms for CT additional to those defined in Table C.8.Y.1-3. for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007).

**Table C.8.X.2.1.1.3-1  
IMAGE TYPE AND FRAME TYPE VALUE 3 FOR CT**

Defined Term Name	Defined Term Description
ATTENUATION	Collected for the purpose of performing attenuation corrections (e.g. PET attenuation correction)
CARDIAC	Cardiac images
CARDIAC_GATED	Cardiac gated images
REFERENCE	Collected for anatomical reference for PET or SPECT

### C.8.X.2.1.1.4 Derived Pixel Contrast

455 Table C.8.X.2.1.1.4-1 specifies the Defined Terms for CT additional to those defined in Table C.8.Y.1.4-1 for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007).

**Table C.8.X.2.1.1.4-1  
IMAGE TYPE AND FRAME TYPE VALUE 4 FOR CT**

Defined Term Name	Defined Term Description
FILTERED	An image filter has been applied
MEDIAN	Pixel by pixel median

### 460 C.8.X.3 Enhanced CT Image Functional Group Macros

The following sections contain Functional Group macros specific to the Enhanced CT Image IOD.

Note: The attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the macro is part of the Per-frame Functional Groups Sequence). If an attribute is applicable to all frames (i.e. the macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the attribute description shall be interpreted to mean "for all frames".

465

**C.8.X.3.1 CT Frame Type Macro**

Table C.8.X-9 specifies the attributes of the CT Image Frame Type Functional Group macro.

**Table C.8.X-9  
CT IMAGE FRAME TYPE MACRO ATTRIBUTES**

470

Attribute Name	Tag	Type	Attribute Description
CT Image Frame Type Sequence	(0018,9329)	1	Identifies the characteristics of this frame. Only a single Item shall be permitted in this sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued attribute analogous to the Image Type (0008,0008).  Enumerated Values and Defined Terms are the same as those for the four values of the Image Type (0008,0008) attribute, except that the value MIXED is not allowed. See sections C.8.Y.1 and C.8.X.2.1.1.1.
> Include Common CT/MR Image Description Macro' Table C.8.Y.2-1			

**C.8.X.3.1a CT Acquisition Type Macro**

Table C.8-X.10 specifies the attributes of the CT Acquisition Type Functional Group macro.

**Table C.8-X.10  
CT ACQUISITION TYPE MACRO ATTRIBUTES**

475

Attribute Name	Tag	Type	Attribute Description
CT Acquisition Type Sequence	(0018,9301)	1	Contains the attributes defining the CT acquisition mode. Only a single Item shall be permitted in this sequence.
>Acquisition Type	(0018,9302)	1C	Description of the method used during acquisition of this frame. See C.8.X.3.1.1 for the defined terms.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Tube Angle	(0018,9303)	1C	The constant angle at which the x-ray source is located during acquisition. 0 degrees means that the source is located at the highest point of the gantry orbit. Degrees increase from 0 to positive 360 in a clockwise direction as viewed when facing the gantry where the table enters the gantry.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is CONSTANT_ANGLE.

			May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is CONSTANT_ANGLE.
>Constant Volume Flag	(0018,9333)	1C	<p>Identifies that the acquisition was performed by repetitively acquiring the same volume set over a period of time.</p> <p>Note: The Acquisition Type (0018,9302) value may be SEQUENCED, SPIRAL or STATIONARY depending on whether table movement is necessary to cover the volume.</p> <p>Enumerated Values YES NO</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Fluoroscopy Flag	(0018,9334)	1C	<p>Identifies that near real-time display of a block of continuously acquired data was performed, which may result in a lower than usual image quality.</p> <p>Enumerated Values YES NO</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>

**C.8.X.3.1.1 Acquisition Type**

Acquisition Type (0018,9302) has the following Defined Terms:

480	SEQUENCED	identifies that the acquisition was performed by acquiring single or multi detector data while rotating the source about the gantry while the table is not moving. Additional slices are acquired by incrementing the table position and again rotating the source about the gantry while the table is not moving.
485	SPIRAL	identifies that the acquisition was performed by acquiring data while rotating the source about the gantry while continuously moving the table.
	CONSTANT_ANGLE	identifies that the acquisition was performed by holding the source at a constant angle and moving the table to obtain a projection image (e.g., a localizer image).
490	STATIONARY	identifies that the acquisition was performed by holding the table at a constant position and acquiring multiple slices over time at the same location.

FREE

identifies that the acquisition was performed while rotating the source about the gantry while the table movement is under direct control of a human operator or under the control of an analysis application (e.g., fluoroscopic image).

495

**C.8.X.3.2 CT Acquisition Details Macro**

Table C.8-X.11 specifies the attributes of the CT Acquisition Details Functional Group macro.

**Table C.8-X.11  
CT ACQUISITION DETAILS MACRO ATTRIBUTES**

500

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
CT Acquisition Details Sequence	(0018,9304)	1	Contains the attributes defining the details of the acquisition. Only a single Item shall be permitted in this sequence.
>Rotation Direction	(0018,1140)	1C	<p>Direction of rotation of the source about the gantry, as viewed while facing the gantry where the table enters the gantry.</p> <p>Enumerated Values:            CW = clockwise            CC = counter clockwise</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.</p> <p>Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.</p>
>Revolution Time	(0018,9305)	1C	<p>The time in seconds of a complete revolution of the source around the gantry orbit. This value is independent of the Reconstruction Angle (0018,9319) of the frame.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.</p> <p>Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.</p>

>Single Collimation Width	(0018,9306)	1C	<p>The width of a single row of acquired data (in mm).</p> <p>Note: Adjacent physical detector rows may have been combined to form a single effective acquisition row.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Total Collimation Width	(0018,9307)	1C	<p>The width of the total collimation (in mm) over the area of active x-ray detection.</p> <p>Note: This will be equal to the number of effective detector rows multiplied by single collimation width.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Table Height	(0018,1130)	1C	<p>The distance in mm from the top of the patient table to the center of rotation of the source (i.e. the data collection center or isocenter). The distance is positive when the table is below the data collection center.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Gantry/Detector Tilt	(0018,1120)	1C	<p>Nominal angle of tilt in degrees of the scanning gantry. Not intended for mathematical computations. Zero degrees means the gantry is not tilted, negative degrees are when the top of the gantry is tilted away from where the table enters the gantry.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Data Collection Diameter	(0018,0090)	1C	<p>The diameter in mm of the region over which data were collected. See C.8.X.3.4.1.</p> <p>Note: In the case of an Acquisition Type (0018,9302) of CONSTANT_ANGLE, the diameter is that in a plane normal to the central ray of the diverging X-ray beam as it passes through the data collection center.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>



**C.8.X.3.3 CT Table Dynamics Macro**

Table C.8-X.12 specifies the attributes of the CT Table Dynamics Functional Group macro.

**Table C.8-X.12  
CT TABLE DYNAMICS MACRO ATTRIBUTES**

505

Attribute Name	Tag	Type	Attribute Description
CT Table Dynamics Sequence	(0018,9308)	1	Contains the attributes defining the movement of the CT table. Only a single Item shall be permitted in this sequence.
>Table Speed	(0018,9309)	1C	The distance in mm that the table moves in one second during the gathering of data that resulted in this frame.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is SPIRAL or CONSTANT_ANGLE.  May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is SPIRAL or CONSTANT_ANGLE.
>Table Feed per Rotation	(0018,9310)	1C	Motion of the table (in mm) during a complete revolution of the source around the gantry orbit.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is SPIRAL.  May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is SPIRAL.
>Spiral Pitch Factor	(0018,9311)	1C	Ratio of the Table Feed per Rotation (0018,9310) to the Total Collimation Width (0018,9307).  See C.8.X.2.4.1 for further explanation and some examples.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is SPIRAL.  May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is SPIRAL.

**C.8.X.3.3.1 Spiral Pitch Factor**

The formula for Spiral Pitch Factor (0018,9311) in terms of Table Feed per Rotation (0018,9310) and Total Collimation Width (0018,9307) is:

510 Spiral Pitch Factor = (Table Feed per Rotation (mm))/(Total Collimation Width (mm))

An example calculation of Spiral Pitch Factor (0018,9311) for a single slice spiral acquisition of an image with a Total Collimation Width of 2.5mm and a Table Feed per Rotation of 10mm is:

$$\text{Spiral Pitch Factor} = (10 \text{ mm}) / (2.5 \text{ mm}) = 4.0$$

515 An example calculation of Spiral Pitch Factor (0018,9311) for a multiple slice spiral acquisition having a Total Collimation Width of 20mm and a Table Feed per Rotation of 10mm is:

$$\text{Spiral Pitch Factor} = (10 \text{ mm}) / (20 \text{ mm}) = 0.5$$

### C.8.X.3.3A CT Position

Table C.8-X.12a specifies the attributes of the CT Position Functional Group macro.

**Table C.8-X.12a**  
**CT POSITION MACRO ATTRIBUTES**

520

Attribute Name	Tag	Type	Attribute Description
CT Position Sequence	(0018,9326)	1	Contains the attributes defining the CT geometry. Only a single Item shall be permitted in this sequence.
>Table Position	(0018,9327)	1C	Relative longitudinal position of acquisition location of this frame in mm from an implementation specific reference point. Shall be relative to the same reference point for all frames in this SOP Instance, but may be different from the reference point in other SOP Instances. Positions as the table moves into the gantry viewed from the front are more negative.  Notes: 1. For contiguous slices reconstructed from multiple detectors one would expect different values for adjacent slices. 2. Lateral positioning or tilting or swiveling are not described.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Data Collection Center (Patient)	(0018,9313)	1C	The x, y, and z coordinates (in the patient coordinate system) in mm of the center of the region in which data were collected. See C.8.X.3.4.1.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

>Reconstruction Target Center (Patient)	(0018,9318)	1C	<p>The x, y, and z coordinates (in the patient coordinate system) of the reconstruction center target point as used for reconstruction in mm. See C.8.X.3.4.1.</p> <p>Note: If the reconstructed image is not magnified or panned the value corresponds with the Data Collection Center (0018,9313) attribute.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
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**C.8.X.3.4 CT Geometry Macro**

Table C.8-X.13 specifies the attributes of the CT Geometry Functional Group macro.

**Table C.8-X.13  
CT GEOMETRY MACRO ATTRIBUTES**

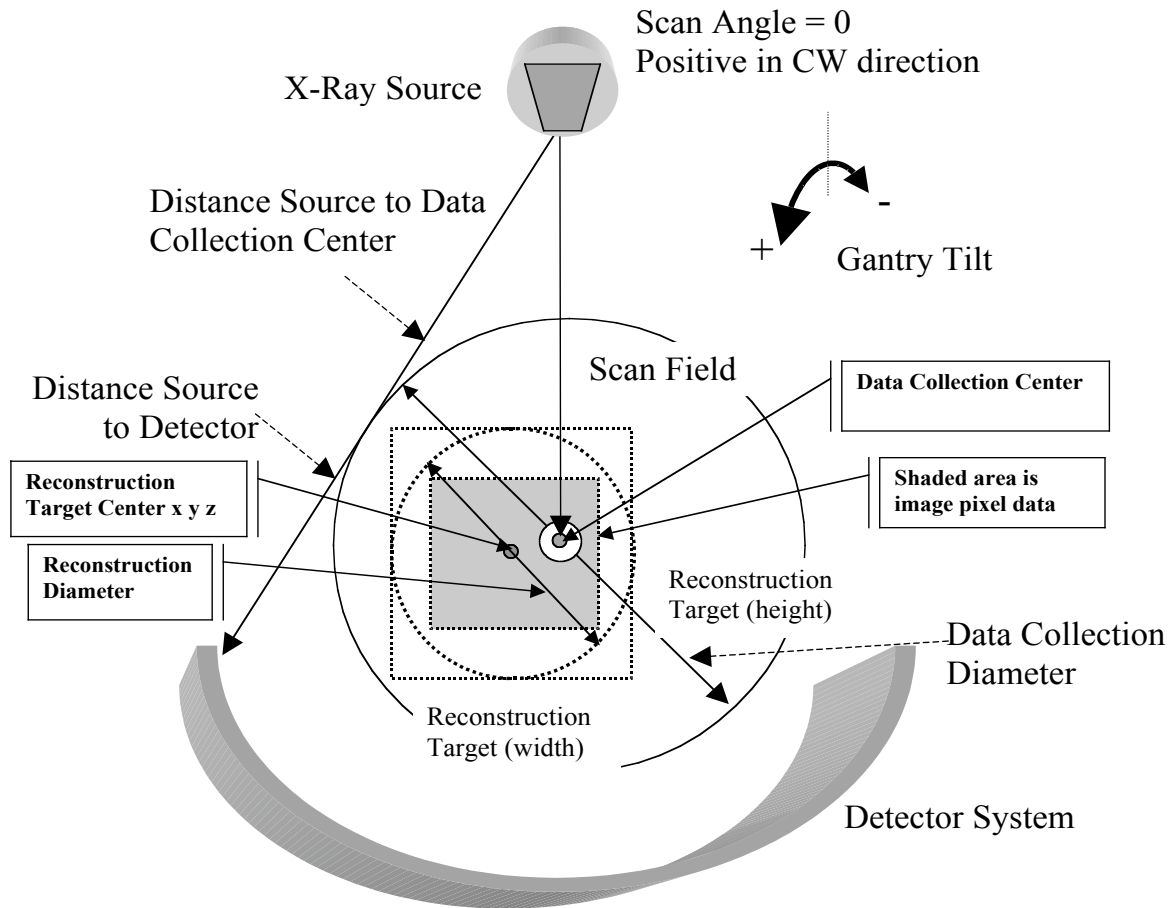
525

Attribute Name	Tag	Type	Attribute Description
CT Geometry Sequence	(0018,9312)	1	Contains the attributes defining the CT geometry. Only a single Item shall be permitted in this sequence.
>Distance Source to Detector	(0018,1110)	1C	<p>Distance in mm from source to detector center. See C.8.X.3.4.1.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Distance Source to Data Collection Center	(0018,9335)	1C	<p>Distance in mm from source to data collection center. See C.8.X.3.4.1.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>

**C.8.X.3.4.1 Relationships Between CT Geometric Attributes (Informative)**

In Figure C.8.X-1 the relationship of the Geometric Attributes within the CT Geometry and CT Reconstruction functional groups is shown. The figure, viewed from the front of the gantry (where the table enters the gantry), is informative only and is not meant to represent a standardization of an equipment-based frame of reference.

530



**Figure C.8.X-1: Geometry of CT Acquisition System**

535 **C.8.X.3.5 CT Reconstruction Macro**

Table C.8-X.14 specifies the attributes of the CT Reconstruction Functional Group macro.

**Table C.8-X.14  
 CT RECONSTRUCTION MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
CT Reconstruction Sequence	(0018,9314)	1	Contains the attributes holding information about the reconstruction techniques used. Only a single Item shall be permitted in this sequence.

>Reconstruction Algorithm	(0018,9315)	1C	<p>Description of the algorithm used when reconstructing the image from the data acquired during the acquisition process.</p> <p>Defined Terms:          FILTER_BACK_PROJ          ITERATIVE</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Convolution Kernel	(0018,1210)	1C	<p>A label describing the convolution kernel or algorithm used to reconstruct the data.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.</p>
>Convolution Kernel Group	(0018,9316)	1C	<p>A label describing the group that the Convolution Kernel (0018,1210) belongs.</p> <p>Defined Terms:          BRAIN          SOFT_TISSUE          LUNG          BONE          CONSTANT_ANGLE</p> <p>Required if Convolution Kernel (0018,1210) is present. May be present otherwise.</p>
>Reconstruction Diameter	(0018,1100)	1C	<p>The diameter in mm of the region from which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. See C.8.X.3.4.1.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL, may not be present if Reconstruction Field of View (0018,9317) is present.</p> <p>Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Reconstruction Field of View (0018,9317) is not present.</p>
>Reconstruction Field of View	(0018,9317)	1C	<p>The field of view width (x-dimension) followed by height (y-dimension) as used for reconstruction in mm.</p> <p>Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL, may not be present if Reconstruction Diameter (0018,1100) is present.</p>

>Reconstruction Pixel Spacing	(0018,9322)	1C	Physical distance in the patient between the center of each reconstructed pixel, specified by a numeric pair – adjacent row spacing (delimiter) adjacent column spacing in mm.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Reconstruction Angle	(0018,9319)	1C	Angle (in degrees) over which the data from which the frame was reconstructed was collected, where 360 degrees signifies a complete revolution of the source around the gantry orbit. It is possible, in the case of over-scanning that the Reconstruction Angle is greater than 360 degrees.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Image Filter	(0018,9320)	1C	A label describing the filter applied to the reconstructed image after the original reconstruction has been completed.  Note: When Frame Type (0008,9007) Value 1 of this frame is DERIVED and Frame Type (0008,9007) Value 4 is FILTERED the type of filtration is described in Derivation Image Macro.  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL.

540 **C.8.X.3.6 CT Exposure Macro**

Table C.8-X.15 specifies the attributes of the CT Exposure Functional Group macro.

**Table C.8-X.15  
CT EXPOSURE MACRO ATTRIBUTES**

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
CT Exposure Sequence	(0018,9321)	1	Contains the attributes defining exposure information. Only a single Item shall be permitted in this sequence.
>Exposure Time in ms	(0018,9328)	1C	Duration of exposure for this frame in milliseconds. If Acquisition Type (0018,9302) equals SPIRAL the duration of exposure shall be weighted by the Spiral Pitch Factor (0018,9311).  Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

>X-ray Tube Current in mA	(0018,9330)	1C	Nominal X-ray tube current in milliamperes. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Exposure in mAs	(0018,9332)	1C	The exposure expressed in milliamperere seconds, for example calculated from exposure time and X-Ray tube current. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Exposure Modulation Type	(0018,9323)	1C	A label describing the type of exposure modulation used for the purpose of limiting the dose.  Defined Terms: NONE Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Estimated Dose Saving	(0018,9324)	2C	A percent value of dose saving due to the use of Exposure Modulation Type (0018,9323). A negative percent value of dose savings reflects an increase of exposure. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Exposure Modulation Type (0018,9323) is not equal to NONE.  Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Exposure Modulation Type (0018,9323) is not equal to NONE.
>CTDI <sub>vol</sub>	(0018,9445)	2C	Computed Tomography Dose Index (CTDI <sub>vol</sub> ), in mGy according to IEC 60601-2-44, Ed.2.1 (Clause 29.1.103.4), The Volume CTDI <sub>vol</sub> . It describes the average dose for this frame for the selected CT conditions of operation.

545 Note: The dose that a patient receives in a given procedure should be found in the Radiation Module of the relevant Modality Performed Procedure Step IOD.

**C.8.X.3.7 CT X-ray Details Macro**

Table C.8-X.16 specifies the attributes of the CT X-ray Details Functional Group macro.

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**Table C.8-X.16  
CT X-RAY DETAILS SEQUENCE MACRO ATTRIBUTES**

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
CT X-ray Details Sequence	(0018,9325)	1	Contains the attributes defining the x-ray information. Only a single Item shall be permitted in this sequence.
>KVP	(0018,0060)	1C	Peak kilo voltage output of the x-ray generator used. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Focal Spot(s)	(0018,1190)	1C	Used nominal size of the focal spot in mm. The attribute may only have one or two values, for devices with variable focal spot, small dimension followed by large dimension Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Filter Type	(0018,1160)	1C	Type of filter(s) inserted into the X-Ray beam. Defined Terms: WEDGE BUTTERFLY MULTIPLE FLAT SHAPED NONE Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Filter Material	(0018,7050)	1C	The X-Ray absorbing material used in the filter. May be multi-valued. Defined Terms: MOLYBDENUM ALUMINUM COPPER RHODIUM NIOBIUM EUROPIUM LEAD Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.



**C.8.X.3.8 CT Pixel Value Transformation Macro**

Table C.8-X.17 specifies the attributes of the CT Pixel Value Transformation Functional Group macro.

555

- Notes: 1. This Macro is equivalent with the Modality LUT transformation in non Multi-frame IODs.  
2. This in effect specializes the C.7.6.16.2.9 Pixel Value Transformation Macro.

**Table C.8-X.17  
CT PIXEL VALUE TRANSFORMATION MACRO ATTRIBUTES**

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
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.
>Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052).
>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. If Frame Type (0008,9007) Value 1 of this frame is ORIGINAL, the value shall be HU (Hounsfield Units).

560

**C.8.Y Common CT and MR Descriptions**

This section contains descriptions of Macros and Attributes used in Modules and Functional Group Macros that are common to the Enhanced CT Image, Enhanced MR Images and MR Spectroscopy IODs.

565 **C.8.Y.1 Image Type and Frame Type**

The Image Type (0008,0008) and associated Image Type related attributes provide a high level description of a multi-frame SOP Instance. These attributes describe properties that provide key summary information to users of the SOP Instance. Image Type (0008,0008) contains the highest level summary of what is in the SOP Instance.

570 The Frame Type (0008,9007) attribute mirrors the corresponding Image Type attribute and applies to the frame level rather than to the image level.

If more than one value is used by the set of frames for a given Frame Type (0008,9007) attribute value or associated attribute value then the corresponding value of the Image Type (0008,0008) or associated attribute shall contain a value of MIXED. This indicates that a mixed set of values exists within the multi-frame SOP Instance.

580 The value MIXED shall only be used in the Image Type (0008,0008) when the corresponding values for the individual frames are not equal. When a value of an attribute is equal for all frames, the same value shall be used for the corresponding value of the Image Type (0008,0008). Values 2 and 3 of Image Type (0008,0008) are an exception to the rule for MIXED: Values 2 and 3 may never have the value of MIXED as described in sections C.8.Y.1.2 and C.8.Y.1.3.

Image Type (0008,0008) and Frame Type (0008,9007) shall consist of four non-zero length values.

**C.8.Y.1.1 Pixel Data Characteristics**

585 Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) shall use one of the following Enumerated Values from Table C.8.Y-1.

Value 1 of Image Type (0008,0008) and Value 1 of Frame Type (0008,9007) shall not be zero length.

**Table C.8.Y-1  
IMAGE TYPE AND FRAME TYPE VALUE 1**

Enumerated Value Name	Enumerated Value Description
ORIGINAL	An image or frame is original if its pixel data was directly reconstructed from the original data that is obtained from the sensors of the imaging equipment, Image Type (0008,0008) Value 4 is NONE, and Volume Based Calculation Technique (0008,9207) is NONE. Notes: (1) For MR, original data is data directly reconstructed from k-space data. (2) For CT, original frames are those directly reconstructed from projection data.
DERIVED	An image or frame is derived if its pixel data was calculated from original or other derived pixel data (i.e. it is not original).

MIXED	Used only as a value in Image Type (0008,0008) if frames within the SOP Instance contain different values for Value 1 in their Frame Type (0008,9007).
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**C.8.Y.1.2 Patient Examination Characteristics**

Value 2 for Image Type (0008,0008) and Frame Type (0008,9007) follows the standard definition and shall have the following Enumerated Value from Table C.8.Y.1.2-1.

Value 2 of Image Type (0008,0008) and Value 2 of Frame Type (0008,9007) shall not be zero length.

595

**Table C.8.Y.1.2-1  
IMAGE TYPE AND FRAME TYPE VALUE 2**

Enumerated Value Name	Enumerated Value Description
PRIMARY	See C.7.6.1.1.2

**C.8.Y.1.3 Image Flavor**

600

Value 3 is an overall representation of the image type. This value may be a summary of several other attributes or a duplication of one of the other attributes to indicate the most important aspect of this image. Value 3 Image Flavor is to be used with Value 4 Derived Pixel Contrast to indicate the nature of the image set.

605

Note: For example Value 3 = DIFFUSION together with Value 4 = NONE indicates that the image set was originally collected for DIFFUSION.  
If Value 3 = DIFFUSION together with Value 4 = DIFFUSION this indicates that the object contains DIFFUSION weighted post processed images.

Value 3 of Image Type (0008,0008) shall not be zero length.

610

Value 3 of Frame Type (0008,9007) may have the same value as found in Value 3 of Image Type (0008,0008), or may have a different value or may be of zero length.

The attribute value may not be MIXED as this value needs to be a summary of the primary purpose of the images, whether the frames have the same value or not.

615

Table C.8.Y.1.3-1 specifies the Defined Terms for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007) that are common to CT and MR. Additional defined terms are defined in the modality-specific Module and Macro definitions.

**Table C.8.Y.1.3-1  
IMAGE TYPE AND FRAME TYPE VALUE 3 COMMON**

Defined Term Name	Defined Term Description
ANGIO	Collected for the purpose of angiography
FLUOROSCOPY	Real-time collection of single slices (e.g. CT or MR Fluoroscopy)
LOCALIZER	Collected for the purpose of planning other images.
MOTION	Collected for looking at body motion

PERFUSION	Collected for the purposes of perfusion calculations.
PRE_CONTRAST	Collected before contrast was administered
POST_CONTRAST	Collected during or after contrast was administered
REST	Cardiac rest image set
STRESS	Cardiac stress image set
VOLUME	Set of frames that define a volume

**C.8.Y.1.4 Derived Pixel Contrast**

620 Value 4 shall be used to indicate derived pixel contrast – generally, contrast created by combining or processing images with the same geometry. Value 4 shall have a value of NONE when Value 1 is ORIGINAL.

Note: If more than one of the following derived types is applicable, then it is up to the generating application to specify the value that best characterizes the derived image.

625 Value 4 of Image Type (0008,0008) and Value 4 of Frame Type (0008,9007) shall not be zero length.

Tables C.8.Y.1.4-1 specifies the Defined Terms for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007) that are common to CT and MR. Additional defined terms are defined in the modality-specific Module and Macro definitions.

630

**Table C.8.Y.1.4-1  
IMAGE TYPE AND FRAME TYPE VALUE 4 COMMON**

Defined Term Name	Defined Term Description
ADDITION	Created through Pixel by pixel addition operation
DIVISION	Created through Pixel by pixel division operation
MASKED	Created through Pixel by pixel masking operation
MAXIMUM	Created through Pixel by Pixel Maximum operation
MEAN	Created through Pixel by pixel mean operation
MINIMUM	Created through Pixel by Pixel Minimum operation
MTT	Mean Transit Time
MULTIPLICATION	Created through Pixel by pixel multiplication operation
RCBF	Regional Cerebral Blood Flow (rCBF)
RCBV	Regional Cerebral Blood Volume (rCBV)
RESAMPLED	Pixels have been spatially re-sampled, e.g., MPR
STD_DEVIATION	Standard Deviation
SUBTRACTION	Created through Pixel by pixel subtraction operation
T_TEST	Student's T-Test
TTP	Time To Peak map
Z_SCORE	Z-Score Map
NONE	Not a calculated image

MIXED	Used only as value in Image Type (0008,0008) if frames within the image SOP Instance contain different values for value 4 in their Frame Type (0008,9007) attribute.
-------	--

**C.8.Y.2 Common CT/MR Image Description Macro**

This section describes the Common CT/MR Image Description Macro.

635 Table C.8.Y.2-1 specifies the attributes of the Common CT/MR Image Description Macro.

**Table C.8.Y.2-1  
COMMON CT/MR IMAGE DESCRIPTION MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Pixel Presentation	(0008,9205)	1	Indication of the presence or absence of color information that may be used during rendering. See C.8.Y.2.1.1 for a description and Enumerated Values.
Volumetric Properties	(0008,9206)	1	Indication if geometric manipulations are possible with frames in the SOP Instance. See C.8.Y.2.1.2 for a description and Enumerated Values.
Volume Based Calculation Technique	(0008,9207)	1	Method used for volume calculations with frames in the SOP Instance. See C.8.Y.2.1.3 for a description and Defined Terms.

**C.8.Y.2.1 Common CT/MR Image Description Attribute Description**

640 **C.8.Y.2.1.1 Pixel Presentation**

*... moved here from existing C.8.13.3.1.2 and amended as follows ...*

**Table C.8.13-9  
PIXEL PRESENTATION ATTRIBUTE VALUES**

Enumerated Value Name	Enumerated Value Description
...	
MIXED	Used only as a value in Pixel Presentation (0008,9205) in the Enhanced MR Image Module <b>or Enhanced CT Image Module</b> if frames within the image SOP Instance contain different values for the Pixel Presentation attribute in the MR Image Frame Type Functional Group <b>or CT Image Frame Type Functional Group</b> .

645 **C.8.Y.2.1.1.1 Supplemental Palette Color LUTs**

*... moved here from existing C.8.13.3.1.2.1 ...*

**C.8.Y.2.1.2 Volumetric Properties**

... move here from C.8.13.3.1.3, amended as follows ...

650

**Table C.8.13-10  
VOLUMETRIC PROPERTIES ATTRIBUTE VALUES**

Enumerated Value Name	Enumerated Value Description
...	
MIXED	<p>Used only as a value in the Volumetric Properties (0008,9206) attribute in the Enhanced MR Image Type Module <del>or, MR Spectroscopy Module</del> <u>or Enhanced CT Image Type Module</u> if frames within the image SOP Instance contain different values for the Volumetric Properties (0008,9206) attributes in the MR Image Frame Type Functional Group <del>or, MR Spectroscopy Frame Type Functional Group</del> <u>or CT Frame Type Functional Group.</u></p>

**C.8.Y.2.1.3 Volume Based Calculation Technique Attribute**

... move here from C.8.13.3.1.4, unchanged ...

655

660

**Changes to NEMA Standards Publication PS 3.4-2003**

665

**Digital Imaging and Communications in Medicine (DICOM)**

**Part 4: Service Class Specifications**

**Item #5: Add the following to Table B.5-1**

## B.5 STANDARD SOP CLASSES

670

**Table B.5-1  
STANDARD SOP CLASSES**

<b>SOP Class Name</b>	<b>SOP Class UID</b>	<b>IOD Specification (defined in PS 3.3)</b>
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1	Enhanced CT Image

**Item #6: Add section to B.5.1**

### B.5.1.X Enhanced CT Image Storage SOP Class

675

An SCP of the Enhanced CT Image Storage SOP Class shall also support the Grayscale Softcopy Presentation State Storage SOP Class.

Note: This requirement is present in order to allow the exchange of graphical annotations created by an acquisition device.

680

**Item #7: Add the following to Table I.4-1**

## I.4 MEDIA STORAGE STANDARD SOP CLASSES

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

<b>SOP Class Name</b>	<b>SOP Class UID</b>	<b>IOD Specification</b>
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1	IOD defined in PS 3.3

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**Changes to NEMA Standards Publication PS 3.6-2003**

**Digital Imaging and Communications in Medicine (DICOM)**

**Part 6: Data Dictionary**

**Item #8: Change the following Data Elements to Part 6 Section 6:**

**6 Registry of DICOM data elements**

Tag	Name	VR	VM
(0018,1046)	Contrast Flow Rate <del>(s)</del>	DS	1-n
(0018,1047)	Contrast Flow Duration <del>(s)</del>	DS	1-n

700

**Item #9: Add or the following Data Elements to Part 6 Section 6:**

Tag	Name	VR	VM
(0018,9301)	CT Acquisition Type Sequence	SQ	1
(0018,9302)	Acquisition Type	CS	1
(0018,9303)	Tube Angle	FD	1
(0018,9304)	CT Acquisition Details Sequence	SQ	1
(0018,9305)	Revolution Time	FD	1
(0018,9306)	Single Collimation Width	FD	1
(0018,9307)	Total Collimation Width	FD	1
(0018,9308)	CT Table Dynamics Sequence	SQ	1
(0018,9309)	Table Speed	FD	1
(0018,9310)	Table Feed per Rotation	FD	1
(0018,9311)	Spiral Pitch Factor	FD	1
(0018,9312)	CT Geometry Sequence	SQ	1
(0018,9313)	Data Collection Center (Patient)	FD	3
(0018,9314)	CT Reconstruction Sequence	SQ	1
(0018,9315)	Reconstruction Algorithm	CS	1
(0018,9316)	Convolution Kernel Group	CS	1
(0018,9317)	Reconstruction Field of View	FD	2
(0018,9318)	Reconstruction Target Center (Patient)	FD	3
(0018,9319)	Reconstruction Angle	FD	1
(0018,9320)	Image Filter	SH	1
(0018,9321)	CT Exposure Sequence	SQ	1
(0018,9322)	Reconstruction Pixel Spacing	FD	2
(0018,9323)	Exposure Modulation Type	CS	1
(0018,9324)	Estimated Dose Saving	FD	1
(0018,9325)	CT X-ray Details Sequence	SQ	1

Tag	Name	VR	VM
(0018,9326)	CT Position Sequence	SQ	1
(0018,9327)	Table Position	FD	1
(0018,9328)	Exposure Time in ms	FD	1
(0018,9329)	CT Image Frame Type Sequence	SQ	1
(0018,9330)	X-Ray Tube Current in mA	FD	1
(0018,9332)	Exposure in mAs	FD	1
(0018,9333)	Constant Volume Flag	CS	1
(0018,9334)	Fluoroscopy Flag	CS	1
(0018,9335)	Distance Source to Data Collection Center	FD	1
(0018,9337)	Contrast/Bolus Agent Number	US	1
(0018,9338)	Contrast/Bolus Ingredient Code Sequence	SQ	1
(0018,9340)	Contrast Administration Profile Sequence	SQ	1
(0018,9341)	Contrast/Bolus Usage Sequence	SQ	1
(0018,9342)	Contrast/Bolus Agent Administered	CS	1
(0018,9343)	Contrast/Bolus Agent Detected	CS	1
(0018,9344)	Contrast/Bolus Agent Phase	CS	1
(0018,9345)	CTDIvol	FD	1

**Item #10: Add the following UID to Part 6 Annex A:**

705

**Annex A Registry of DICOM unique identifiers (UID)  
(Normative)**

**Table A-1  
UID VALUES**

UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.5.1.4.1.1.2.1	Enhanced CT Image Storage	SOP Class	PS 3.4

710

715

## **Changes to NEMA Standards Publication PS 3.15-2003**

### **Digital Imaging and Communications in Medicine (DICOM)**

720

#### **Part 15: Security Profiles**

**Item #11: Add to Section C2 and C3**

**C.2 CREATOR RSA DIGITAL SIGNATURE PROFILE**

...

- 725 a. the SOP Class and Instance UIDs  
b. the SOP Creation Date and Time, if present  
c. the Study and Series Instance UIDs  
d. any attributes of the General Equipment module that are present  
e. any attributes of the Overlay Plane, Curve or Graphic Annotation modules that are  
730 present  
f. any attributes of the General Image and Image Pixel modules that are present  
g. any attributes of the SR Document General and SR Document Content modules that  
are present  
h. any attributes of the Waveform and Waveform Annotation modules that are present  
735 i. any attributes of the Multi-frame Functional Groups module that are present  
j. any attributes of the Enhanced MR Image module that are present  
k. any attributes of the MR Spectroscopy modules that are present  
l. any attributes of the Raw Data module that are present  
m. **any attributes of the Enhanced CT Image module that are present**

740

**C.3 AUTHORIZATION RSA DIGITAL SIGNATURE PROFILE**

...

- 745 a. the SOP Class and Instance UIDs  
b. the Study and Series Instance UIDs  
c. any attributes whose Values are verifiable by the technician or physician (e.g., their  
Values are displayed to the technician or physician)  
d. any attributes of the Overlay Plane, Curve or Graphic Annotation modules that are  
present  
750 e. any attributes of the General Image and Image Pixel modules that are present  
f. any attributes of the SR Document General and SR Document Content modules that  
are present  
g. any attributes of the Waveform and Waveform Annotation modules that are present  
h. any attributes of the Multi-frame Functional Groups module that are present  
755 i. any attributes of the Enhanced MR Image module that are present  
j. any attributes of the MR Spectroscopy modules that are present  
k. any attributes of the Raw Data module that are present  
l. **any attributes of the Enhanced CT Image module that are present**

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**Changes to NEMA Standards Publication PS 3.16-2003**

**Digital Imaging and Communications in Medicine (DICOM)**

**Part 16: Content Mapping Resource**

770

**Item #12: Changes and add the following CIDs to Part 6 Annex B:**

**Annex B DCMR Context Groups (Normative)**

...

**CID 4009 DX Anatomy Imaged**

775

**Context ID 4009  
DX Anatomy Imaged**

**Type: Extensible Version: 20040114**

<b>Coding Scheme Designator (0008,0102)</b>	<b>Code Value (0008,0100)</b>	<b>Code Meaning (0008,0104)</b>
<i>INCLUDE CID 4031 Common Anatomic Regions</i>		

**CID 4030 CT and MR Anatomy Imaged**

780

**Context ID 4030  
CT and MR Anatomy Imaged**

**Type: Extensible Version: 20040114**

<b>Coding Scheme Designator (0008,0102)</b>	<b>Code Value (0008,0100)</b>	<b>Code Meaning (0008,0104)</b>
<i>INCLUDE CID 4031 Common Anatomic Regions</i>		
SNM3	T-42501	Abdominal aorta
SNM3	T-42303	Aortic arch
SNM3	T-45011	Carotid
SNM3	T-A600A	Cerebellum
SNM3	T-45526	Circle of Willis
SNM3	T-A0193	Cranial venous system
SNM3	T-41040	Iliac arterial system
SNM3	T-62002	Liver
SNM3	T-D4034	Pancreas
SNM3	T-D4909	Kidney
SNM3	T-D4035	Spleen
SNM3	T-9400F	Testis
SNM3	T-4600A	Thoracic aorta
SNM3	T-C8001	Thymus
SNM3	T-83009	Uterus

**CID 4031 Common Anatomic Regions**

**Context ID 4031  
Common Anatomic Regions**

**Type: Extensible Version: 20020904**

785

<b>Coding Scheme Designator (0008,0102)</b>	<b>Code Value (0008,0100)</b>	<b>Code Meaning (0008,0104)</b>
SNM3	T-D4000	Abdomen
SNM3	T-15420	Acromioclavicular joint
SNM3	T-15750	Ankle joint
SNM3	T-280A0	Apex of Lung
SNM3	T-D8200	Arm
SNM3	T-60610	Bile duct
SNM3	T-74000	Bladder
SNM3	T-04000	Breast
SNM3	T-26000	Bronchus
SNM3	T-12770	Calcaneus
SNM3	T-11501	Cervical spine
SNM3	T-D3000	Chest
SNM3	T-12310	Clavicle
SNM3	T-11BF0	Coccyx
SNM3	T-58200	Duodenum
SNM3	T-D8300	Elbow
SNM3	T-56000	Esophagus
SNM3	T-D0300	Extremity
SNM3	T-11196	Facial bones
SNM3	T-12710	Femur
SNM3	T-D8800	Finger
SNM3	T-D9700	Foot
SNM3	T-12402	Forearm bone
SNM3	T-63000	Gall bladder
SNM3	T-D8700	Hand
SNM3	T-D1100	Head
SNM3	T-32000	Heart
SNM3	T-15710	Hip joint
SNM3	T-12410	Humerus
SNM3	T-D9200	Knee



SNM3	T-59000	Large intestine
SNM3	T-24100	Larynx
SNM3	T-D9400	Leg
SNM3	T-11503	Lumbar spine
SNM3	T-11180	Mandible
SNM3	T-11133	Mastoid bone
SNM3	T-11170	Maxilla
SNM3	T-D1217	Maxilla and mandible
SNM3	T-D3300	Mediastinum
SNM3	T-11149	Nasal bone
SNM3	T-D1600	Neck
SNM3	T-11102	Optic canal
SNM3	T-D1480	Orbit
SNM3	T-22000	Paranasal sinus
SNM3	T-61100	Parotid gland
SNM3	T-12730	Patella
SNM3	T-D6000	Pelvis
SNM3	T-59600	Rectum
SNM3	T-11300	Rib
SNM3	T-15680	Sacroiliac joint
SNM3	T-11AD0	Sacrum
SNM3	T-12280	Scapula
SNM3	T-D1460	Sella turcica
SNM3	T-12980	Sesamoid bones of foot
SNM3	T-D2220	Shoulder
SNM3	T-11100	Skull
SNM3	T-58000	Small intestine
SNM3	T-11500	Spine
SNM3	T-15610	Sternoclavicular joint
SNM3	T-11210	Sternum
SNM3	T-57000	Stomach
SNM3	T-61300	Submandibular gland
SNM3	T-15770	Tarsal joint
SNM3	T-15290	Temporomandibular joint
SNM3	T-11502	Thoracic spine
SNM3	T-D8810	Thumb
SNM3	T-D9800	Toe

SNM3	T-25000	Trachea
SNM3	T-70010	Upper urinary tract
SNM3	T-75000	Urethra
SNM3	T-D6151	Uterus and fallopian tubes
SNM3	T-D8600	Wrist
SNM3	T-11167	Zygomatic arch

*Editors note: T-D6151, T-D1480 and T-D1217 are not correct, and will likely be replaced by T-88920, T-D0801 and T-D1213 respectively with CP-426.*

790 ...

**CID 13 Radiographic Contrast Agent Ingredient**

**Context ID 13**

**Radiographic Contrast Agent Ingredient**

**Type: Extensible Version: 20040114**

<b>Coding Scheme Designator (0008,0102)</b>	<b>Code Value (0008,0100)</b>	<b>Code Meaning (0008,0104)</b>
SRT	C-11400	Iodine
SRT	C-17800	Gadolinium
SRT	C-10520	Carbon Dioxide
SRT	C-12200	Barium
SRT	C-17200	Xenon

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