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DICOM Correction Item

Correction Number		CP-433
Log Summary: Retire Ultrasound Frame of Reference		
Type of Modification	Name of Standard	
Correct Value	PS 3.3 2003	
Rationale for Correction: The Ultrasound Frame of Reference Module and the frame-based spatial transformation are insufficient for implementation. Inability to implement this feature was a prime motivation for Supplement 43: 3D/4D Ultrasound.		
Sections of documents affected PS3.3 : A.1.4, A.6.4, A.7.4, C.8.5.4, C.8.5.5, C.8.5.6		
Correction Wording:		

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2 Remove the US Frame of Reference Module from the Table A.1-1, Composite Information Object Modules Overview – Images, in A.1.4.

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**Table A.1-1
COMPOSITE INFORMATION OBJECT MODULES OVERVIEW – IMAGES**

IODs Modules	CR	CT	MR	Enh MR	NM	US	US MF	SC	SC MF SB	SC MF GB	SC MF GW	SC MF TC	XA	RF	RT IM	PET	DX	MG	IO	VL EN	VL MC	VL SL	VL PH	
Patient	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Specimen Identification				U													U	U	U		M	M	C	
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
General Series	M	M	M	M	M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
CR Series	M																							
NM/PET Patient Orientation					M												M							
PET Series																	M							
PET Isotope																	M							
PET Multi-gated Acquisition																	C							
RT Series																M								
DX Series																		M	M	M				
Mammo Series																			M					
Intra-oral Series																				M				
Frame Of Reference		M	M	M	U	U	U									U	M	U	C	U			M	
U S Frame of Ref.						C	C																	

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Remove the US Frame of Reference Module from the A.6.4 US Image IOD Module Table.

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A.6.4 US Image IOD Module Table

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**Table A.6-1
US IMAGE IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
	US Frame of Reference	C.8.5.4	C - Required if images are spatially related
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Image (See A.6.4.1)	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image
	Palette Color Lookup Table	C.7.9	C - Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR
	US Region Calibration	C.8.5.5	U
	US Image	C.8.5.6	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
Curve (See A.6.4.1)	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	Audio	C.10.3	U
	SOP Common	C.12.1	M

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Note: The US Frame of Reference Module was previously included in this IOD, but has been retired. See PS 3.3 2003.

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Remove the US Frame of Reference Module from the A.7.4 US Multi-Frame Image IOD Module Table.

4 **A.7.4 US Multi-Frame Image IOD Module Table**

6 **Table A.7-1
US MULTI-FRAME IMAGE IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
	US Frame of Reference	C.8.5.4	C - Required if images are spatially related
	Synchronization	C.7.4.2	C – Required if Modality (0008,0060) = IVUS. May be present otherwise.
Equipment	General Equipment	C.7.5.1	M
Image (See A.7.4.1)	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image.
	Cine	C.7.6.5	M
	Multi-frame	C.7.6.6	M
	Palette Color Lookup Table	C.7.9	C - Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR
	US Region Calibration	C.8.5.5	U
	US Image	C.8.5.6	M
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
Curve (see A.7.4.1)	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	Audio	C.10.3	U
	SOP Common	C.12.1	M

8 **Note: The US Frame of Reference Module was previously included in this IOD, but has been retired. See PS 3.3 2003.**

Retire the C.8.5.4, US Frame of Reference Module.

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C.8.5.4 US Frame of Reference Module (Retired)

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Table C.8-16 contains IOD Attributes that describe an ultrasound frame of reference.

Section C.8.5.4 was defined in a previous version of the DICOM Standard. The Section

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is now retired. See PS 3.3 2003.

Table C.8-16

8

US FRAME OF REFERENCE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Region Location Min x_0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 for further explanation.
Region Location Min y_0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 for further explanation.
Region Location Max x_1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 for further explanation.
Region Location Max y_1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 for further explanation.
Physical Units X Direction	(0018,6024)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 for Enumerated Values.
Physical Units Y Direction	(0018,6026)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 for Enumerated Values.
Physical Delta X	(0018,602C)	1	The physical value increments per positive X pixel increment. The units are as specified in the Physical units data element.
Physical Delta Y	(0018,602E)	1	The physical value increments per positive Y pixel increment. The units are as specified in the Physical units data element.
Reference Pixel x_0	(0018,6020)	3	This coordinate pair, x_0, y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 for further explanation.
Reference Pixel y_0	(0018,6022)	3	This coordinate pair, x_0, y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 for further explanation.
Ref. Pixel Physical Value X	(0018,6028)	3	The Physical Value at the reference pixel x location. The units are specified in the Physical Units field.
Ref. Pixel Physical Value Y	(0018,602A)	3	The Physical Value at the reference pixel y location. The units are specified in the Physical Units field.

2 *Move the explanations for Elements included in both the C.8.5.4: US Frame of Reference*
4 *Module, and the C.8.5.5: US Region Calibration Module, from sub-sections of C.8.5.4 to*
6 *C.8.5.5.*

6 *Remove the sub-sections from C.8.5.4.*

8 **C.8.5.4.1 — US Frame of Reference Attribute Definitions**

10 **C.8.5.4.1.1 — Region Location Min x_0 , Region Location Min y_0 , Region Location Max**
12 **x_1 , Region Location Max y_1**

10 The bounds of a rectangle specifying the location of the region, Region Location Min x_0
12 (0018,6018), Region Location Min y_0 (0018,601A), Region Location Max x_1 (0018,601C),
14 Region Location Max y_1 (0018,601E). The upper left corner of the entire image is $x=0,y=0$
and the lower right corner is $x=\text{image width}-1$, and $y=\text{image length}-1$. Thus, a region will be
specified as within these bounds. Where x_0,y_0 is the coordinate of the upper left corner of
the region and x_1,y_1 is the coordinate of the lower right corner of the region.

16 **C.8.5.4.1.2 — Physical Units X Direction And Physical Units Y Direction**

18 Physical Units X Direction (0018,6024) and Physical Units Y Direction (0018,6026) provide
Enumerated Values indicating the physical units of the dimensions of the region.

Value	Meaning	Value	Meaning
0000H =	None or not applicable	0001H =	Percent
0002H =	dB	0003H =	cm
0004H =	seconds	0005H =	hertz(seconds ⁻¹)
0006H =	dB/seconds	0007H =	cm/sec
0008H =	cm ²	0009H =	cm ² /sec
000AH =	cm ³	000BH =	cm ³ /sec
000CH =	degrees		

20 **C.8.5.4.1.3 — Reference Pixel x_0 and Reference Pixel y_0**

22 This coordinate pair, Reference Pixel x_0 (0018,6020), Reference Pixel y_0 (0018,6022)
defines the location of a virtual "reference" pixel. The reference pixel is used to tie the image's
pixel coordinate system to the physical coordinate system. For example, the reference pixel
could be defined where a depth of zero centimeters occurs in the 2D image, or it could define
where the baseline (i.e.: zero frequency) resides in a spectral display. The reference pixel
location is the relative offset from the region location, not necessarily the image origin. The
location is not required to be within the region or even within the image boundary. For this
reason, the Reference Pixel Location can be positive or negative.
Recommended locations are:

- 30 —Sector — Skin line
- Linear — Skin line left corner
- 32 —Doppler Spectral — Baseline left
- M-Mode — Skin line left
- 34 —Physio — Baseline left (where baseline = 0)

36 *Update the referenced section numbers in Table C.8-17, US Region Calibration Module*
38 *Attributes, so that the refer to the moved sections. If the existing sub-sections of C.8.5.5 are*
renumbered because of the move then update the references to these sub-sections as well.

C.8.5.5 US Region Calibration Module

2 The US Region Calibration Module has been introduced into the ultrasound IOD to provide
4 access to the full range of data which may be present in a single US image. US images often
6 contain multiple regions which have independent data regions, e.g. quad screen loops which
8 may have different calibration information. The data presented in the various regions of a US
10 image can represent a multiplicity of physical parameters, e.g., spatial distance, blood
velocity, time, volume, etc., and these are often contained in the value of the pixel itself. It is
therefore imperative that physical information be available for the various regions of a single
region independent of each other.

C.8.5.5.1 US Region Calibration Attribute Definitions

12 Table C.8-17 contains IOD Attributes that describe an ultrasound region calibration.

14 **Table C.8-17**
US REGION CALIBRATION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Sequence of Ultrasound Regions	(0018,6011)	1	Defines a sequence of Ultrasound Regions. One or more Items may be included in this Sequence.
>Region Location Min x_0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 C.8.5.5.1.x for further explanation.
>Region Location Min y_0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 C.8.5.5.1.x for further explanation.
>Region Location Max x_1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 C.8.5.5.1.x for further explanation.
>Region Location Max y_1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x_0, y_0, x_1, y_1 . See C.8.5.4.1.1 C.8.5.5.1.x for further explanation.
>Physical Units X Direction	(0018,6024)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 C.8.5.5.1.y for Enumerated Values.
>Physical Units Y Direction	(0018,6026)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 C.8.5.5.1.y for Enumerated Values.
>Physical Delta X	(0018,602C)	1	The physical value increments per positive X pixel increment. The units are as specified in the physical units data element.

>Physical Delta Y	(0018,602E)	1	The physical value increments per positive Y pixel increment. The units are as specified in the physical units data element.
>Reference Pixel x_0	(0018,6020)	3	This coordinate pair, x_0, y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 C.8.5.5.1.z for further explanation.
>Reference Pixel y_0	(0018,6022)	3	This coordinate pair, x_0, y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 C.8.5.5.1.z for further explanation.
>Ref. Pixel Physical Value X	(0018,6028)	3	The Physical Value at the reference pixel x location. The units are specified in the Physical Units field.
>Ref. Pixel Physical Value Y	(0018,602A)	3	The Physical Value at the reference pixel y location. The units are specified in the Physical Units field.
>Region Spatial Format	(0018,6012)	1	The spatial organization of the data within the region. See C.8.5.5.1.1 for Enumerated Values.
>Region Data Type	(0018,6014)	1	The type of data within the region. See C.8.5.5.1.2 for Enumerated Values.
>Region Flags	(0018,6016)	1	Flags used for special handling of the region. See C.8.5.5.1.3 for Enumerated Values and further explanation.
>Pixel Component Organization	(0018,6044)	1C	Describes how the components of a pixel can be described. Required if pixel component calibration exists for this region. See C.8.5.5.1.4 for Enumerated Values and further explanation.
>Pixel Component Mask	(0018,6046)	1C	This value is ANDed with the composite pixel code for each pixel within the region, then shifted right by the number of contiguous least significant zeros in the mask to obtain what will be referred to as the "Shifted Masked Composite Pixel Code" (SMCPC). Required if Pixel Component Organization = Bit aligned. See C.8.5.5.1.5 for further explanation.
>Pixel Component Range Start	(0018,6048)	1C	Defines the start of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.

>Pixel Component Range Stop	(0018,604A)	1C	Defines the stop of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.
>Pixel Component Physical Units	(0018,604C)	1C	The physical units to be applied to the pixel component. Required if Pixel Component Organization exists. See C.8.5.5.1.6 for further explanation.
>Pixel Component Data Type	(0018,604E)	1C	The type of data for the pixel component. Required if Pixel Component Organization exists. See C.8.5.5.1.7 for further explanation.
>Number of Table Break Points	(0018,6050)	1C	The number of break point coordinate pairs used to describe a piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See C.8.5.5.1.8 for further explanation.
>Table of X Break Points	(0018,6052)	1C	An array of X values used to create the piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See C.8.5.5.1.9 for further explanation.
>Table of Y Break Points	(0018,6054)	1C	An array of Y values used to create the piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See C.8.5.5.1.9 for further explanation.
>Number of Table Entries	(0018,6056)	1C	The number of entries in the Table of Pixel Values. Required if the Pixel Component Organization equals 2. Otherwise not used. See C.8.5.5.1.11 for further explanation.
>Table of Pixel Values	(0018,6058)	1C	A table of Pixel Values used in conjunction with the Table of Parameter Values to provide a mapping from Pixel Value to Parameter Value. Required if the Pixel Component Organization equals 2. Otherwise not used. See C.8.5.5.1.12 for further explanation.

>Table of Parameter Values	(0018,605A)	1C	A table of Parameter Values used in conjunction with the Table of Pixel Values to provide a mapping from Pixel Value to Parameter Value. Required if the Pixel Component Organization equals 2. Otherwise not used. See C.8.5.5.1.13 for further explanation
>Tranducer Frequency	(0018,6030)	3	The manufacturer defined description of center frequency of the interrogating ultrasound energy. The units are kilohertz.
>Pulse Repetition Frequency	(0018,6032)	3	The ultrasound pulse repetition frequency, as defined by the manufacturer, used to collect data in the region. The units are in hertz.
>Doppler Correction Angle	(0018,6034)	3	The Doppler correction angle. The units are degrees.
>Steering Angle	(0018,6036)	3	The steering angle, as defined by the manufacturer, used for a steered 2D image. The units are degrees.
>Doppler Sample Volume X Position	(0018,6039)	3	The x displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>Doppler Sample Volume Y Position	(0018,603B)	3	The y displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>TM-Line Position x_0	(0018,603D)	3	The starting and ending coordinates pairs of the m-line. Where the X_0, Y_0 are the starting point and X_1, Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.
>TM-Line Position y_0	(0018,603F)	3	The starting and ending coordinates pairs of the m-line. Where the X_0, Y_0 are the starting point and X_1, Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.
>TM-Line Position x_1	(0018,6041)	3	The starting and ending coordinates pairs of the m-line. Where the X_0, Y_0 are the starting point and X_1, Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.
>TM-Line Position y_1	(0018,6043)	3	The starting and ending coordinates pairs of the m-line. Where the X_0, Y_0 are the starting point and X_1, Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.

Add the following sections moved from the Retired C.8.5.4.1 to C.8.5.5.1. If sub-section numbering is started from 1 then the existing sub-section numbers for C.8.5.5.1 must be incremented and the references to these sub-sections in Table C.8-17 must also be updated. Note that Supplement 84 proposes significant changes and additions to these sections and also proposes a new section, C.8.5.4.4.

C.8.5.4.1.1 C.8.5.5.1.x Region Location Min x_0 , Region Location Min y_0 , Region Location Max x_1 , Region Location Max y_1

The bounds of a rectangle specifying the location of the region, Region Location Min x_0 (0018,6018), Region Location Min y_0 (0018,601A), Region Location Max x_1 (0018,601C), Region Location Max y_1 (0018,601E). The upper left corner of the entire image is $x=0,y=0$ and the lower right corner is $x=\text{image width} - 1$, and $y=\text{image length} - 1$. Thus, a region will be specified as within these bounds. Where x_0,y_0 is the coordinate of the upper left corner of the region and x_1,y_1 is the coordinate of the lower right corner of the region.

C.8.5.4.1.2 C.8.5.5.1.y Physical Units X Direction And Physical Units Y Direction
Physical Units X Direction (0018,6024) and Physical Units Y Direction (0018,6026) provide Enumerated Values indicating the physical units of the dimensions of the region.

<u>Value</u>	<u>Meaning</u>	<u>Value</u>	<u>Meaning</u>
0000H =	None or not applicable	0001H =	Percent
0002H =	dB	0003H =	cm
0004H =	seconds	0005H =	hertz(seconds ⁻¹)
0006H =	dB/seconds	0007H =	cm/sec
0008H =	cm ²	0009H =	cm ² /sec
000AH =	cm ³	000BH =	cm ³ /sec
000CH =	degrees		

C.8.5.4.1.3 C.8.5.5.1.z Reference Pixel x_0 and Reference Pixel y_0

This coordinate pair, Reference Pixel x_0 (0018,6020), Reference Pixel y_0 (0018,6022) defines the location of a virtual "reference" pixel. The reference pixel is used to tie the image's pixel coordinate system to the physical coordinate system. For example, the reference pixel could be defined where a depth of zero centimeters occurs in the 2D image, or it could define where the baseline (i.e.: zero frequency) resides in a spectral display. The reference pixel location is the relative offset from the region location, not necessarily the image origin. The location is not required to be within the region or even within the image boundary. For this reason, the Reference Pixel Location can be positive or negative.

Recommended locations are:

- Sector - Skin line
- Linear - Skin line left corner
- Doppler Spectral - Baseline left
- M-Mode - Skin line left
- Physio - Baseline left (where baseline = 0)

2 Remove Image Transformation Matrix and Image Translation Vector from Table C.8-18 and
 4 Retire all of section C.8.5.6.1.9 Image Transformation Matrix and Image Translation Vector

6 **Table C.8-18**
US IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
...			
Image Transformation Matrix	(0018,5210)	3	Transformation Matrix, as described in C.8.5.6.1.9. Used for spatially related images where the relationship includes rotations.
Image Translation Vector	(0018,5212)	3	Translation Vector as described in C.8.5.6.1.9. Used for spatially related images where the relationship includes translations.
...			

8 **C.8.5.6.1.9 Image Transformation Matrix and Image Translation Vector (Retired)**

10 This section was defined in a previous version of the DICOM Standard. The Section is
 12 now retired. See PS 3.3 2003.

14 In spatially related US images it is necessary to be able to convert data from the (x', y',
 16 z') coordinate system of the echo plane into the (x, y, z) coordinate system of the frame
 18 of reference. It is assumed that the echo plane is a right handed, orthogonal Cartesian
 20 coordinate system, with its origin at the Reference Pixel as defined in the US Frame Of
 22 Reference Module, such that +x' is directed to the right, +y' is directed toward the top
 24 of the screen, and +z' is directed out of the screen toward the viewer. From this
 definition z' = 0 everywhere on the echo plane. (x, y, z) is a similar right-handed
 system. The origin of (x', y', z') lies at the point (x₀, y₀, z₀) in the (x, y, z) system (x₀ in
 vector notation). Once the appropriate translation has been applied, the two coordinate
 systems are related by a 3x3 rotation matrix A, such that a point r' in (x', y', z') may be
 converted to r in ((x, y, z) by a matrix multiplication and translation:

$$r = Ar' + x_0$$

24 These two operations may be combined in a single matrix multiplication by appending
 the translation vector to the rotation matrix:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & x_0 \\ a_{21} & a_{22} & a_{23} & y_0 \\ a_{31} & a_{32} & a_{33} & z_0 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

26 **Eq C.8-1**

28 Where each a_{ij} represents the cosine of the angle between the ith unit vector of the (x',
 30 y', z') system and the jth unit vector of the (x, y, z) system, or i•j. These nine rotation
 components are not independent, but rather are constrained by the orthonormality
 condition to

$$\sum_{i=1}^3 a_{ij} a_{ik} = \delta_{jk}$$

32 where δ_{jk} is the Kronecker delta function, 0 for j≠k, and 1 for j=k.
 Taking advantage of the fact that z' = 0, Eq. C.8-1 can be reduced to:

$$\begin{bmatrix} a_{11} & a_{12} & 0 & x_0 \\ a_{21} & a_{22} & 0 & y_0 \\ a_{31} & a_{32} & 0 & z_0 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

2

Eq C.8-2

4 **The Image Transformation Matrix (0018,5210) shall consist of the direction cosines in the following order:**

$$\underline{a_{11}, a_{21}, a_{31}, a_{12}, a_{22}, a_{32}}$$

6 **The Image Translation Vector (0018,5212) shall consist of the translation elements from Eq C.8-2 in the following order:**

8

$$\underline{x_0, y_0, z_0}$$

10 **The frame of reference (x, y, z) shall be defined by the first image in a spatially related series. Subsequent rotations of θ about x (fan), y (propeller) or z (panorama) shall have the following Image Transformation Matrices:**

12

$$\begin{matrix} \text{FAN:} & \begin{bmatrix} 1 & 0 \\ 0 & \cos \theta \\ 0 & \sin \theta \end{bmatrix} & \text{PROP:} & \begin{bmatrix} \cos \theta & 0 \\ 0 & 1 \\ -\sin \theta & 0 \end{bmatrix} & \text{PAN:} & \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \\ 0 & 0 \end{bmatrix} \end{matrix}$$

14

The convention used for rotation shall be positive when it appears counterclockwise when looking from the +x axis of rotation to the origin.

16

Retire the Image Transformation Matrix and Image Translation Vector data elements from PS 3.6

18

(0018,5210) Image Transformation Matrix DS 6 **RET**

(0018,5212) Image Translation Vector DS 3 **RET**

20