DICOM Correction Proposal

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Correction Number	CP-1237
Log Summary: Equally spaced Planes in Enhanced US Volume	
Name of Standard PS 3.3 - 2011	

Rationale for Correction:
The Enhanced US Volume IOD is constrained to have equally spaces slices (existing A.59.1 and C.8.24.3.3 text), but:
 	
  1. The description of Position Measuring Device Used (0018,980C) in the Enhanced US Image Module includes a reference to Spacing Between Slices (0018,0088). Spacing Between Slices (0018,0088) was included in an earlier draft of Supplement 43 but had been removed prior to Final Text. Constraints exist to ensure that planes within the Ultrasound Volume are equally spaced (see item **Error! Reference source not found.** but Spacing Between Slices (0018,0088) is not the means for enforcing this constraint.
 	
  2. In A.59.1 the text describing that planes within the Ultrasound Volume are equally spaced is arguably not normative.
 	
Correct the Position Measuring Device Used description and add normative text that is consistent in the invocation of the Plane Position (Volume) and Plane Orientation (Volume) macros and the description of the Dimensions.	

Correction Wording:	

C.8.24.3 Enhanced US Image Module

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Table C.8.24.3-1
ENHANCED US IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
…			
Position Measuring Device Used	(0018,980C)	1C	~~Indicates the~~ **Describes the type of** position measuring device used in the acquisition of the image, ~~which implies~~**if any. This gives an indication of** the degree of precision of ~~the~~ Pixel Spacing (0028,0030) and ~~**Spacing Between Slices (0018,0088) values**__ **the spacing between adjacent planes**. Enumerated Values: RIGID The image was acquired with a position measuring device. FREEHAND The image was acquired without a position measuring device. Required if Volumetric Properties (0008,9206) is VOLUME and Volume Based Calculation Technique (0008,9207) is NONE. May be present otherwise.
…			

A.59 ENHANCED ULTRASOUND VOLUME INFORMATION OBJECT DEFINITION

A.59.1 Enhanced US Volume IOD Description

Image objects of different types may be created from a 3D Ultrasound image acquisition, illustrated in Figure A.59-1. It can be seen that there are two different types of data related to 3D image acquisition: 3D volume datasets and several kinds of 2D image derived from the volume dataset.

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The 3D volume dataset (the diagonally shaded box in Figure A.59-1) contains a Cartesian volume or two or more temporally related Cartesian volumes. 3D volume datasets are exchanged using the Enhanced US Volume SOP Class, and are suitable for subsequent Multi-Planar Reconstruction and rendering operations. Within each Enhanced US Volume instance, each Cartesian volume consists of a set of parallel planes, and each plane consists of one or more frames each of a single data type. All Cartesian volumes have the same spacing between adjacent planes.

Most acquisition devices construct the Cartesian volume by resampling data from a different acquisition geometry. The method of generation of the Cartesian volume, its relationship to spatially-related 2D frames (whether the volume was created from spatially-related frames, or spatially-related frames extracted from the Cartesian volume), and the algorithms used for Multi-Planar Reconstruction and rendering operations are outside the scope of this standard.

The 2D image types represent collections of frames that are derived from the volume dataset, namely 3D rendered views (projections), separate Multi-Planar Reconstructed (MPR) views, or sets of spatially-related source frames, either parallel or oblique (the cross-hatched boxes in Figure A.59-1). The Ultrasound Image and Ultrasound Multiframe Image IOD's are used to represent these derived images. See Section A.6 for the Ultrasound Image IOD description or section A.7 for the Ultrasound Multi-frame Image IOD description.

PS 3.3 A.59.4.1.2: Add normative text to Plane Position (Volume) and Plane Orientation (Volume) Macros invocation to describe equal spacing of adjacent planes:

A.59.4.1.2   Plane Position (Volume) and Plane Orientation (Volume) Macros

Image Position (Volume) (0020,9301) first value (X) shall be zero and second value (Y) shall be zero. Image Orientation (Volume) (0020,9302) values shall be 1\0\0\0\1\0. This ensures that the origins of each frame lies on the Volume Frame of Reference Z_V axis, the rows of each frame are parallel to the Volume Frame of Reference X_V axis, and the columns of each frame are parallel to the Volume Frame of Reference Y_V axis.

Adjacent planes in the volume shall be equally spaced in the Z direction.

> **Notes: 1. More than one frame may be encoded for the same plane, for example, with a different temporal or cardiac cycle position.**
>
> **2. Frames with the same value of Image Position (Volume) (0020,9301) will also have the same second value of Dimension Index Value (the spatial position Dimension); see C.8.24.3.3.**

PS 3.3 C.8.24.3.3: Improve text about equal spacing in the Dimensions definition:

C.8.24.3   Enhanced US Image Module

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C.8.24.3.3   Dimension Organization Type

Dimension Organization Type (0020,9311) specifies the general structure of the image. The concept of "multi-frame dimensions" as specified by the Dimension Index Sequence (0020,9222) and per-frame Dimension Index Values (0020,9157) shall be used to specify the relationships of frames within that general structure.

If Dimension Organization Type (0020,9311) has values of 3D or 3D_TEMPORAL, then the Dimension Index Sequence (0020,9222) shall have exactly three items, with the dimension values described in Table C.8.24.3.3-1.

Table C.8.24.3.3-1
DIMENSION DEFINITION FOR US ACQUISITION 3D IMAGES

Item	Attribute	Tag	Value
Dimension Index Sequence		(0020,9222)	
1st	>Dimension Index Pointer	(0020,9165)	Tag of attribute specifying temporal position of frames
	>Functional Group Pointer	(0020,9167)	Tag of sequence containing above attribute
	…		
2nd	>Dimension Index Pointer	(0020,9165)	(0020,9301) Image Position (Volume)
	>Functional Group Pointer	(0020,9167)	(0020,930E) Plane Position (Volume) Sequence
	…		
3rd	>Dimension Index Pointer	(0020,9165)	(0018,9808) Data Type
	>Functional Group Pointer	(0020,9167)	(0018,9807) Image Data Type Sequence
	…		

The Dimension Index Values (0020,9157) corresponding to these dimension variables positively associate frames with different Data Type values at the same spatial and temporal position. Figure C.8.24.3.3-1 illustrates the use of Dimensions to associate frames with temporal, spatial, and Data Type dimensions.

These Dimension values shall be used even if there is only one possible value for a Dimension.

Note: For example, if Dimension Organization Type (0020,9311) has the value 3D, the temporal position dimension is present and the dimension index of the temporal attribute is the same in every frame of the image. Similarly, if the Data Type attribute is in the Shared Functional Group and all frames in the object are of Data Type TISSUE_INTENSITY, the Data Type dimension is present and the dimension index of the Data Type dimension is the same in every frame of the image.

Each plane in the volume consists of one or more frames each with a distinct value of Data Type (0018,9808). ~~**The planes in the cartesian volume shall have equal inter-plane spacing, accomplished through values of Image Position (Volume) (0020,9301).**~~ **<u>Adjacent planes in the volume shall be equally spaced in the Z direction.</u>**

Each frame comprising a volume shall have the same value of the temporal dimension attribute. Any appropriate physiological event temporal attribute may be used to specify the temporal position. If there is no specific physiological event to which the temporal position of frames is referenced, then Temporal Position Time Offset (0020,930D) in the Temporal Position Sequence (0020,9310) may be used as the temporal dimension attribute. If all frames are at the same temporal position, any temporal attribute may be referenced.

Note: For example, the attribute specifying temporal position of frames may be any appropriate temporal attribute, such as Nominal Cardiac Trigger Delay Time (0020,9153) or Nominal Percentage of Cardiac Phase (0020,9241) in the Cardiac Synchronization Sequence (0018,9118) if the temporal position of frames is referenced to the cardiac R-wave, or Nominal Respiratory Trigger Delay Time (0020,9255) or Nominal Percentage of Respiratory Phase (0020,9245) in the Respiratory Synchonization Sequence (0020,9253) if the temporal position of frames is referenced to the latest inspiration maximum.