

DICOM Correction Item

Correction Number	CP-586
Log Summary: Pixel spacing and calibration in projection radiography	
Type of Modification	Name of Standard
Clarification	PS 3.3, 3.6 2004
<p>Rationale for Correction</p> <p>The attribute Imager Pixel Spacing (0018,1164) is defined in CR, DX family and XA/XRF IODs to specify the physical distance measured at the front plane of the image receptor housing between the center of each pixel.</p> <p>This attribute was added to the CR IOD in CP 66, but prior to that time, a precedent had been set by CR vendors of encoding similar information (the spacing at the front of the CR plate) in the Pixel Spacing (0028,0030) attribute (that is used in CT and MR to define the spacing within the patient) as a Standard Extended CR SOP Class. PACS and other workstation and viewer vendors correspondingly began to make use of (0028,0030) for making measurements and true size printing of CR images, and have in some cases ignored the standard (0018,1164) attribute, even when present. Since that time, many CR vendors have taken to including both attributes with the same value, to accommodate the divergent practice amongst workstations and displays.</p> <p>Unfortunately, a worrying practice has emerged in which the Pixel Spacing (0028,0030) attribute is populated with a value different from Imager Pixel Spacing (0018,1164), derived either:</p> <ul style="list-style-type: none">• automatically, by the devices making assumptions about the geometry and based on those assumptions “correcting” for the effect of geometric magnification, in many cases without documenting the nature of the correction, what triggers it (e.g., body part), and how to suppress it,• manually, by users “calibrating” images by measuring objects of known size included in the image. <p>Further, since displays and print SCUs vary in their choice of Pixel Spacing (0028,0030) or Imager Pixel Spacing (0018,1164) as the basis for performing measurements and for “true size” printing, very often without advising the user of the choice and the implication of the choice, there is a potential safety hazard resulting from the divergent interpretation of these attributes.</p> <p>Accordingly, it is proposed to make clear that Imager Pixel Spacing (0018,1164) shall never be altered to account for geometric magnification by calibration, and that Pixel Spacing (0028,0030) may optionally be present in a CR or XA/XRF or DX family images with either the same value as in Imager Pixel Spacing (0018,1164) if uncorrected or uncalibrated, or a different value only if corrected or calibrated. The meaning of different values for Imager Pixel Spacing (0018,1164) and Pixel Spacing (0028,0030) shall be interpreted to mean that the image has been corrected or calibrated.</p> <p>Further, an explanation of the nature of the correction or calibration applied to determine the value encoded in Pixel Spacing (0028,0030) is added in order to allow the display or print SCU application to advise the warn the user or annotate the true size film appropriately.</p> <p>Note that the new Supplement 83 introduces an X-Ray Projection Pixel Calibration Macro with a new attribute Object Pixel Spacing in Center of Beam (0018,9404), but that is not used here because the issue is that of clarifying widespread existing practice rather than solving the problem <i>de novo</i>.</p>	

The Device Module, which is already present in XA/XRF/DX, is added as optional to the CR IOD should it be desired to further describe any fiducial device used for calibration.

This proposal addresses all common usage that is known at this point, with the exception of one case in which the value of Imager Pixel Spacing (0018,1164) is encoded incorrectly for other reasons, which has been addressed by a product recall.

In addition, since calibration is frequently required for the use of scanned film, whether the films are projection radiographs or printed cross-sectional images, the mechanism is extended to support the difference between the Nominal Scanned Pixel Spacing (0018,2010) if present, the possibility of calibrating the Pixel Spacing (0028,0030) attribute, and the state of uncertainty that exists when Pixel Spacing (0028,0030) is present alone in single-frame secondary capture images.

Sections of documents affected
 PS 3.3 10, A.2.3, C.8.1.2, C.8.7.2, C.8.11.4
 PS 3.6

Correction Wording:

Create a new macro to add the optional attributes for correction and calibration, with a name distinct from that used in Sup 83 in Section 10:

10.X BASIC PIXEL SPACING CALIBRATION MACRO

Table 10-X defines the Attributes for the Basic Pixel Spacing Calibration Macro.

**Table 10.X-1
 BASIC PIXEL SPACING CALIBRATION MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Pixel Spacing	(0028,0030)	1C	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. See 10.X.1.1.
Pixel Spacing Calibration Type	(0028,0402)	3	The type of correction for the effect of geometric magnification or calibration against an object of known size, if any. See 10.X.1.2.

Pixel Spacing Calibration Description	(0029,0404)	1C	<p>A free text description of the type of correction or calibration performed.</p> <p>Notes: 1. In the case of correction, the text might include description of the assumptions made about the body part and geometry and depth within the patient.</p> <p>2. in the case of calibration, the text might include a description of the fiducial and where it is located (e.g., "XYZ device applied to the skin over the greater trochanter").</p> <p>3. Though it is not required, the Device Module may be used to describe the specific characteristics and size of the calibration device.</p> <p>Required if Pixel Spacing Calibration Type (0028,0402) is present.</p>
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10.X.1 Basic Pixel Spacing Macro Attribute descriptions

10.X.1.1 Pixel Spacing

The Pixel Spacing (0028,0030) attribute specifies the physical distance in the patient between the center of each pixel.

If the image has not been calibrated to correct for the effect of geometric magnification, the values of this attribute shall be the same as in Imager Pixel Spacing (0018,1164) or Nominal Scanned Pixel Spacing (0018,2010), if either of those attributes are present.

If the values are different from those in Imager Pixel Spacing (0018,1164) or Nominal Scanned Pixel Spacing (0018,2010), then the image has been corrected for known or assumed geometric magnification or calibrated with respect to some object of known size at known depth within the patient.

If Pixel Spacing Calibration Type (0028,0402) and Imager Pixel Spacing (0018,1164) and Nominal Scanned Pixel Spacing (0018,2010) are absent, then it cannot be determined whether or not correction or calibration have been performed.

- Notes: 1. Imager Pixel Spacing (0018,1164) is a required attribute in DX family IODs.
2. Nominal Scanned Pixel Spacing (0018,2010) is a required attribute in Multi-frame SC family IODs

10.X.1.2 Pixel Spacing Calibration Type

The Pixel Spacing Calibration Type (0028,0402) attribute The type of correction for the effect of geometric magnification or calibration against an object of known size, if any.

Enumerated Values:

GEOMETRY the Pixel Spacing (0028,0030) values account for assumed or known geometric magnification effects and correspond to some unspecified depth within in the patient; the Pixel Spacing (0028,0030) values may thus be used for measurements of objects located close to the central ray and at the same depth.

FIDUCIAL the Pixel Spacing (0028,0030) values have been calibrated by the operator or image processing software by measurement of an object (fiducial) that is visible in the pixel data and is of known size and is located close to the central ray; the

Pixel Spacing (0028,0030) values may thus be used for measurements of objects located close to the central ray and located at the same depth within the patient as the fiducial

Add the Device Module as optional to existing IODs that do not already have it:

A.2.3 CR Image IOD Module Table

**Table A.2-1
CR IMAGE IOD MODULES**

IE	Module	Reference	Usage
Image
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image
	<u>Device</u>	<u>C.7.6.12</u>	<u>U</u>
	CR Image	C.8.1.2	M

Add the new macro to the CR Image Module used in the CR IOD:

C.8.1.2 CR Image Module

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**Table C.8-2
CR IMAGE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...
Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel. Specified by a numeric pair - row spacing value (delimiter) column spacing value - in mm. In the case of CR, the front plane is defined to be the external surface of the CR plate closest to the patient and radiation source. <u>The value of this attribute shall never be adjusted to account for correction for the effect of geometric magnification or calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose.</u>
<u>Include Basic Pixel Spacing Calibration Macro (Table 10.X-1)</u>			

Add the new macro to the SC and Multi-frame SC IODs:

C.8.6.2 SC Image Module

Table C.8-25 contains IOD Attributes that describe Secondary Capture Images.

**Table C.8-25
SC IMAGE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Time of Secondary Capture	(0018,1014)	3	The time the Secondary Capture Image was captured.
Nominal Scanned Pixel Spacing	(0018,2010)	3	Physical distance on the media being digitized or scanned between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. Shall be consistent with Pixel Aspect Ratio (0028,0034), if present.
<i>Include Basic Pixel Spacing Calibration Macro (Table 10.X-1)</i>			

C.8.6.3 SC Multi-frame Image Module

**Table C.8-25b
SC MULTI-FRAME IMAGE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...
Nominal Scanned Pixel Spacing	(0018,2010)	1C	Physical distance on the media being digitized or scanned between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. Required if Conversion Type (0008,0064) is DF (Digitized Film). May also be present if Conversion Type (0008,0064) is SD (Scanned Document) or SI (Scanned Image). Shall be consistent with Pixel Aspect Ratio (0028,0034), if present.
<i>Include Basic Pixel Spacing Calibration Macro (Table 10.X-1)</i>			

Add the new macro to the X-Ray Acquisition Module used in the existing XA/XRF IODs:

C.8.7.2 X-Ray Acquisition Module

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**Table C.8-27
X-RAY ACQUISITION MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...
Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel specified

			<p>by a numeric pair - row spacing value(delimiter) column spacing value in mm.</p> <p><u>The value of this attribute shall never be adjusted to account for correction for the effect of geometric magnification or calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose.</u></p>
<i>Include Basic Pixel Spacing Calibration Macro (Table 10.X-1)</i>			

Add the new macro to the DX Detector Module used in the DX family IODs:

C.8.11.4 DX Detector Module

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**Table C.8-71
DX DETECTOR MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...
Imager Pixel Spacing	(0018,1164)	1	<p>Physical distance measured at the front plane of the detector housing between the center of each image pixel specified by a numeric pair - row spacing value(delimiter) column spacing value in mm.</p> <p><u>The value of this attribute shall never be adjusted to account for correction for the effect of geometric magnification or calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose.</u></p>
<i>Include Basic Pixel Spacing Calibration Macro (Table 10.X-1)</i>			
Detector Element Physical Size	(0018,7020)	3	<p>Physical dimensions of each detector element that comprises the detector matrix, in mm.</p> <p>Expressed as row dimension followed by column.</p> <p>Note: This may not be the same as Detector Element Spacing (0018,7022) due to the presence of spacing material between detector elements.</p>
Detector Element Spacing	(0018,7022)	3	<p>Physical distance between the center of each detector element, specified by a numeric pair - row spacing value(delimiter) column spacing value in mm.</p> <p>Note: This may not be the same as the Imager Pixel Spacing (0018,1164), and should not be assumed to describe the stored image.</p>

Add the new data elements to PS 3.6:

<u>(0028,0402)</u>	<u>Pixel Spacing Calibration Type</u>	<u>CS</u>	<u>1</u>
<u>(0028,0404)</u>	<u>Pixel Spacing Calibration Description</u>	<u>LO</u>	<u>1</u>