DICOM Correction Item

Correction Number	CP-517

Log Summary: Clarify Pixel Padding Value must not be in native image

Type of Modification	Name of Standard
Correction	PS 3.3 2004

Rationale for Correction

Pixel Padding Value is intended to flag pixel values that indicate the need for special handling, i.e. that do not occur in the "native" image itself. This is common in CT modalities

However, padding may also be added to an image with pixel values that are in the native image, typically with values of air in projection radiography, in which case recommendations for a sensible value to use are appropriate, but the value used should not be encoded in Pixel Padding Value since it is not different from those occurring in the native image.

Also, the recommend values do not account for the possibility of signed images.

The presence of the word "non-rectangular" was intended to suggest that this mechanism could be used for images with a circular perimeter, but there was never any intent to restrict the padding to only non-rectangular images, and there is no point in such a restriction, so it is removed. It is entirely appropiate to pad rectangular images of different sizes or position to a larger size, for example during resampling after spatial registration, and to convey the Pixel Padding Value used in such circumstances.

Sections of documents affected

PS 3.3 C.7.5.1.1.2

Correction Wording:

Pixel Padding Value	(0028,0120)	3	Value of pixels **not present in the native image** added to ~~non-rectangular~~ **an** image to pad to rectangular format. See C.7.5.1.1.2 for further explanation.
			Note: The Value Representation of this Attribute is determined by the value of Pixel Representation (0028,0103).

C.7.5.1.1   General Equipment Attribute Descriptions

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C.7.5.1.1.2   Pixel Padding Value

Pixel Padding Value (0028,0120) is used to pad ~~non-rectangular~~ images to rectangular format. The native format of some images is not rectangular. It is common for devices with this format to pad the images to the rectangular format required by the DICOM Standard with a specific pixel value that is not contained in the native image. **Further, when resampling, such as after spatial registration, padding may need to be used to fill previously non-existent pixels.**

> Notes: 1. The "native image" is that which is being padded to the required rectangular format, e.g., the area within the circular reconstruction perimeter of a CT image.
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> 2. The pixel padding value is explicitly described in order to prevent display applications from taking it into account when determining the dynamic range of an image, since the Pixel Padding Value will be outside the range between the minimum and maximum values of the pixels in the native image
>
> 3. No pixels in the native image will have a value equal to Pixel Padding Value.

This attribute specifies the value of this padding value.

The value shall be a valid value within the constraints defined by Bits Allocated (0028,0100), Bits Stored (0028,0101), and High Bit (0028,0102).

This Attribute shall not be present when padding is performed but the pixel value used for padding does occur in the native image.

> Notes: 1. When the relationship between pixel value and X-Ray Intensity is unknown, it is recommended that the following values be used to pad with black **when the image is unsigned**:
>
>   0 if Photometric Interpretation (0028,0004) is MONOCHROME2.
> $2^{BitsStored}$ - 1 if Photometric Interpretation (0028,0004) is MONOCHROME1.
>
>   **and when the image is signed:**
>
>   **$-2^{BitsStored-1}$ if Photometric Interpretation (0028,0004) is MONOCHROME2.**
>   **$2^{BitsStored-1}$ - 1 if Photometric Interpretation (0028,0004) is MONOCHROME1.**
>
> 2. **For projection radiography, w**~~W~~hen the relationship between pixel value and X-Ray Intensity is known (for example as defined by Pixel Intensity Relationship (0028,1040) and Pixel Intensity relationship Sign (0028,1041)), it is recommended that a **pixel** value equivalent to**, or rendered similarly to,** air **(least X-Ray absorbance)** be used **for padding. However, if such a value may occur in the native image, the Pixel Padding Value (0028,0120) Attribute itself should not be sent**.
>
>   **E.g., for an XRF image obtained with an image intensifier, if air is black then a padded perimeter, if any, should also appear black. Typically though, if unpadded, this area would be collimated with a circular collimator, in which case the pixels would appear**

natively as white (greatest X-Ray absorbance) and a circular shutter would be necessary to neutralize them as black. Whether collimated areas are detected and treated as padded, or neutralized with shutters is at the discretion of the application. See also the Display Shutter Module C.7.6.11.

When modifying equipment changes the pixel padding value in the image, it shall change the value of Pixel Padding Value (0028,0120). If modifying equipment changes the pixel padding value in the image to a value present in the native image, the attribute Pixel Padding Value (0028,0120) shall be removed.

Note: For example, if a CT image containing signed values from –1024 to 3191 and a Pixel Padding Value of –2000 and a Rescale Intercept of 0 is converted to an unsigned image with a Rescale Intercept of –1024 by adding 1024 to all pixels and clipping all more negative pixels to 0, then the padding pixels will be indistinguishable from some of the modified native image pixels, and hence Pixel Padding Value (0028,0120) needs to be removed.