DICOM Correction Item

Correction Number	CP 414

Log Summary: Clarify Uniqueness of Pixel Padding Value	

Type of Modification	Name of Standard
Clarification	PS 3.3, 3.4 2004

Rationale for Correction

Some implementations interpret the standard definition of the Pixel Padding Value attribute (0028,0120) to allow that value to also occur within the image, due to the following text: "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", which is considered as a recommendation, not a requirement for that value not to be contained in the native image.

It seems to be obvious that such interpretation is wrong, however the implementations exist and thus:

- the use of values from within the native image as Pixel Padding Values should be prohibited, and

- if when an image is modified, the Pixel Padding Value falls within the range of valid pixel values within the modified native image, the Pixel Padding Value attribute should be removed.

Sections of documents affected

PS 3.3 C.7.5.1.1.2

PS 3.4 N.2.1

Correction Wording:

Amend PS 3.3, Section C.7.5.1.1.2 by adding the notes as follows:

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.

> **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.**
>
> **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).

> 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:
>   0 if Photometric Interpretation (0028,0004) is MONOCHROME2.
> $2^{BitsStored}$ - 1 if Photometric Interpretation (0028,0004) is MONOCHROME1.
>
> 2. When 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 value equivalent to air be used.

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.**

Amend PS 3.4, Section N.2.1 by adding the note as follows:

N.2.1   Modality LUT

The Modality LUT transformation transforms the manufacturer dependent pixel values into pixel values which are meaningful for the modality and which are manufacturer independent (e.g., Hounsfield number for CT modalities, Optical Density for film digitizers). These may represent physical units or be dimensionless. The Modality LUT in the Presentation State is modality dependent and is analogous to the same module in an Image .

> Note**s**:   **1.** In some cases, such as the CT Image Storage SOP Class, the same conceptual step as the Modality LUT is specified in another form, for example as Rescale Slope and Rescale Intercept Attributes in the CT Image Module, though the Modality LUT Module is not part of the CT Image IOD.
>
> **2. Image pixel values with a value of Pixel Padding Value (0028,0120) (if present in the image) shall be accounted for prior to entry to the Modality LUT stage. See the definition of Pixel Padding Value in PS 3.3.**