

1	Status	Final Text
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8	Correction Number CP-812	
9	Log Summary: Clarification that Pixel Padding Value is a raw value before any transformations	
10	Name of Standard	
11	PS3.3 2015b	
12	Rationale for Correction:	
13	Whilst it is clear from the context that the pixel padding value refers to the raw untransformed pixel values, this is not explicitly stated	
14	anywhere and has caused confusion amongst some vendors.	
15	Correction Wording:	

Amend DICOM PS3.3 as follows:

### C.7.5.1.1.2 Pixel Padding Value and Pixel Padding Range Limit

Pixel Padding Value (0028,0120) is used to pad grayscale images (those with a Photometric Interpretation of MONOCHROME1 or MONOCHROME2) 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.

Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) are also used to identify pixels to be excluded from the normal grayscale rendering pipeline for other reasons, such as suppression of background air. Pixel Padding Range Limit (0028,0121) is defined in the Image Pixel Module.

#### Note

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, or the subset of the rectangular area that contains useful image information.
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.

Pixel Padding Value (0028,0120) specifies either a single value of this padding value, or when combined with Pixel Padding Range Limit (0028,0121), a range of values (inclusive) that are padding.

The values of Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) shall be valid values within the constraints defined by Bits Allocated (0028,0100), Bits Stored (0028,0101), and High Bit (0028,0102).

**The padding value shall correspond to a value in the original stored pixel data, before the Modality LUT Transformation or any other transformations are applied.**

Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) shall not be present when padding is performed but the pixel value used for padding does occur in the native image.

If Photometric Interpretation (0028,0004) is MONOCHROME2, Pixel Padding Value (0028,0120) shall be less than (closer to or equal to the minimum possible pixel value) or equal to Pixel Padding Range Limit (0028,0121). If Photometric Interpretation (0028,0004) is MONOCHROME1, Pixel Padding Value (0028,0120) shall be greater than (closer to or equal to the maximum possible pixel value) or equal to Pixel Padding Range Limit (0028,0121).

#### Note

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.
  - $2^{\text{Bits Stored}} - 1$  if Photometric Interpretation (0028,0004) is MONOCHROME1.and when the image is signed:
  - $-2^{\text{Bits Stored}-1}$  if Photometric Interpretation (0028,0004) is MONOCHROME2.
  - $2^{\text{Bits Stored}-1} - 1$  if Photometric Interpretation (0028,0004) is MONOCHROME1.
2. For projection radiography, 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 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.

1 E.g., for an XRF image obtained with an image intensifier, if air is black then a padded perimeter, if any, should also  
2 appear black. Typically though, if unpadded, this area would be collimated with a circular collimator, in which case the  
3 pixels would appear natively as white (greatest X-Ray absorbance) and a circular shutter would be necessary to neut-  
4 ralize them as black. Whether collimated areas are detected and treated as padded, or neutralized with shutters is at  
5 the discretion of the application. See also the Display Shutter Module Section C.7.6.11.

- 6 3. The conditional requirement for the Pixel Padding Value Range Limit (0028,0121) in the Image Pixel Module means  
7 that it shall not be present unless Pixel Padding Value (0028,0120) is also present.
- 8 4. The range of values to be suppressed between Pixel Padding Value (0028,0120) and Pixel Padding Value Range Limit  
9 (0028,0121) is specified as being inclusive, that is the values themselves as well as all values between are suppressed.
- 10 5. When Pixel Padding Value Range Limit (0028,0121) is present, but not supported by a rendering application, the constraint  
11 that Pixel Padding Value (0028,0120) is closest to the "blackest" value, which is typically the most frequently occurring  
12 background pixel, will most often result in an acceptable display, permitting "backward compatibility" in the majority of  
13 cases.

14 When modifying equipment changes the pixel padding value in the image, it shall change the values of Pixel Padding Value (0028,0120)  
15 and Pixel Padding Range Limit (0028,0121), if present. If modifying equipment changes the pixel padding values in the image to  
16 values present in the native image, the attribute Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) shall  
17 be removed.

#### 18 **Note**

- 19 1. For example, if a CT image containing signed values from -1024 to 3191 and a Pixel Padding Value of -2000 and a  
20 Rescale Intercept of 0 is converted to an unsigned image with a Rescale Intercept of -1024 by adding 1024 to all pixels  
21 and clipping all more negative pixels to 0, then the padding pixels will be indistinguishable from some of the modified  
22 native image pixels, and hence Pixel Padding Value (0028,0120) needs to be removed.
- 23 2. If the modification involves lossy compression, which may result in changes to the pixel values, then the application of  
24 Pixel Padding Value and Pixel Padding Range Limit may result in a different appearance, and hence these attributes  
25 may need different values also.