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8	Correction Number CP-1565	
9	Log Summary: Clarify Photometric Interpretation after decompression of compressed Transfer Syntaxes	
10	Name of Standard	
11	PS3.5 2016c	
12	Rationale for Correction:	
13	Photometric Interpretation describes how the Pixel Data is currently encoded, not how it might have previously been encoded in	
14	other (e.g., compressed Transfer Syntaxes). The language describing the values to use for specific Transfer Syntaxes can sometimes	
15	be misinterpreted as implying that the value should be preserved on decompression and re-encoding, which is not the intent.	
16	In the case of JPEG 2000, the use of color transformations is signaled in the bit stream and the Photometric Interpretation is required	
17	to be consistent with the bit stream. The circumstances under which other values of Photometric Interpretation may be used are	
18	clarified.	
19	Correction Wording:	

Amend DICOM PS3.5 as follows:

## 8.2.1 JPEG Image Compression

The use of the DICOM Encapsulated Format to support JPEG Compressed Pixel Data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream. The Pixel Data characteristics included in the JPEG Interchange Format shall be used to decode the compressed data stream.

### Note

1. These requirements were formerly specified in terms of the "uncompressed pixel data from which the compressed data stream was derived". However, since the form of the "original" uncompressed data stream could vary between different implementations, this requirement is now specified in terms of consistency with what is encapsulated.

When decompressing, should the characteristics explicitly specified in the compressed data stream (e.g., spatial sub-sampling or number of components or planar configuration) be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed Data Set might be encoded.

2. Those characteristics not explicitly specified in the compressed data stream (e.g., the color space of the compressed components, which is not specified in the JPEG Interchange Format), or implied by the definition of the compression scheme (e.g., always unsigned in JPEG), can therefore be determined from the DICOM Data Element in the enclosing Data Set. For example a Photometric Interpretation of "YBR\_FULL\_422" would describe the color space that is commonly used to lossy compress images using JPEG. It is unusual to use an RGB color space for lossy compression, since no advantage is taken of correlation between the red, green and blue components (e.g., of luminance), and poor compression is achieved.
3. The JPEG Interchange Format is distinct from the JPEG File Interchange Format (JFIF). The JPEG Interchange Format is defined in ??? section 4.9.1, and refers to the inclusion of decoding tables, as distinct from the "abbreviated format" in which these tables are not sent (and the decoder is assumed to already have them). The JPEG Interchange Format does NOT specify the color space. The JPEG File Interchange Format, not part of the original JPEG standard, but defined in ECMA TR-098, and under development as ISO 101918-5, is often used to store JPEG bit streams in consumer format files, and does include the ability to specify the color space of the components. THE JFIF APP0 marker segment is NOT required to be present in DICOM encapsulated JPEG bit streams, and should not be relied upon to recognize the color space. Its presence is not forbidden (unlike the JP2 information for JPEG 2000 Transfer Syntaxes), but it is recommended that it be absent.
4. Should the compression process be incapable of encoding a particular form of pixel data representation (e.g., JPEG cannot encode signed integers, only unsigned integers), then ideally only the appropriate form should be "fed" into the compression process. However, for certain characteristics described in DICOM Data Elements but not explicitly described in the compressed data stream (such as Pixel Representation), then the DICOM Data Element should be considered to describe what has been compressed (e.g., the pixel data really is to be interpreted as signed if Pixel Representation so specifies).
5. DICOM Data Elements should not describe characteristics that are beyond the capability of the compression scheme used. For example, JPEG lossy processes are limited to 12 bits, hence the value of Bits Stored should be 12 or less. Bits Allocated is irrelevant, and is likely to be constrained by the Information Object Definition in ???? to values of 8 or 16. Also, JPEG compressed data streams are always color-by-pixel and should be specified as such (a decoder can essentially ignore this element however as the value for JPEG compressed data is already known).
6. **If JPEG Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR\_FULL\_422 to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.**

## 8.2.2 Run Length Encoding Compression

The use of the DICOM Encapsulated Format to support RLE Compressed Pixel Data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the compressed data.

### Note

1. These requirements were formerly specified in terms of the "uncompressed pixel data from which the compressed data was derived". However, since the form of the "original" uncompressed data stream could vary between different implementations, this requirement is now specified in terms of consistency with what is encapsulated.
2. Those characteristics not implied by the definition of the compression scheme (e.g., always color-by-plane in RLE), can therefore be determined from the DICOM Data Element in the enclosing Data Set. For example a Photometric Interpretation of "YBR\_FULL" would describe the color space that is commonly used to losslessly compress images using RLE. It is unusual to use an RGB color space for RLE compression, since no advantage is taken of correlation between the red, green and blue components (e.g., of luminance), and poor compression is achieved (note however that the conversion from RGB to YBR\_FULL is itself lossy. A new photometric interpretation may be proposed in the future that allows lossless conversion from RGB and also results in better RLE compression ratios).
3. DICOM Data Elements should not describe characteristics that are beyond the capability of the compression scheme used. For example, RLE compressed data streams (using the algorithm mandated in the DICOM Standard) are always color-by-plane.
4. **If RLE Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR\_FULL to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding. It is permitted, however, to leave the YBR\_FULL color components unconverted but decompressed in the Native format, in which case the Photometric Interpretation in the Data Set with the Native encoding would be YBR\_FULL.**

## 8.2.3 JPEG-LS Image Compression

The use of the DICOM Encapsulated Format to support JPEG-LS Compressed Pixel Data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream. The Pixel Data characteristics included in the JPEG-LS Interchange Format shall be used to decode the compressed data stream.

### Note

1. See also the notes in Section 8.2.1.
2. **No Photometric Interpretation specific for JPEG-LS is currently defined in DICOM. Annex F of ISO 14495-2 describes a "Sample transformation for inverse colour transform" and a marker segment to encode its parameters, but this is not known to have been implemented. Common practice is to compress the RGB components unconverted, which sacrifices compression performance, and send the Photometric Interpretation as RGB. Though the YBR\_RCT Photometric Interpretation and component conversion could theoretically be used, in the absence of DC shifting it results in signed values to be encoded, which are not supported by JPEG-LS.**
3. **If JPEG-LS Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from any other Photometric Interpretation to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.**

## 8.2.4 JPEG 2000 Image Compression

The use of the DICOM Encapsulated Format to support JPEG 2000 Compressed Pixel Data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream. The Pixel Data characteristics included in the JPEG 2000 bit stream shall be used to decode the compressed data stream.

### Note

These requirements are specified in terms of consistency with what is encapsulated, rather than in terms of the uncompressed pixel data from which the compressed data stream may have been derived.

When decompressing, should the characteristics explicitly specified in the compressed data stream be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed Data Set might be encoded.

The JPEG 2000 bit stream specifies whether or not a reversible or irreversible multi-component (color) transformation [ISO 15444-1 Annex G], if any, has been applied. If no multi-component transformation has been applied, then the components shall correspond to those specified by the DICOM Attribute Photometric Interpretation (0028,0004). If the JPEG 2000 Part 1 reversible multi-component transformation has been applied then the DICOM Attribute Photometric Interpretation (0028,0004) shall be YBR\_RCT. If the JPEG 2000 Part 1 irreversible multi-component transformation has been applied then the DICOM Attribute Photometric Interpretation (0028,0004) shall be YBR\_ICT.

### Note

1. For example, single component may be present, and the Photometric Interpretation (0028,0004) may be MONO-CHROME2.

2. **The application of a JPEG 2000 Part 1 reversible multi-component transformation is signaled in the JPEG 2000 bitstream by a value of 1 rather than 0 in the SGcod Multiple component transformation type of the COD marker segment [ISO 15444-1 Table A.17]. No other value of Photometric Interpretation than YBR\_RCT or YBR\_ICT is permitted when SGcod Multiple component transformation type is 1.**

3. Though it would be unusual, would not take advantage of correlation between the red, green and blue components, and would not achieve effective compression, a Photometric Interpretation of RGB could be specified as long as no multi-component transformation [ISO 15444-1 Annex G] was specified by the JPEG 2000 bit stream. **Alternative methods of decorrelation of the color components than those specified in [ISO 15444-1 Annex G] are permitted as defined in PS3.3, such as a Photometric Interpretation of YBR\_FULL; this may be useful when converting existing YBR\_FULL Pixel Data (e.g., in a different Transfer Syntax) without further loss.**

**In either case (Photometric Interpretation of RGB or YBR\_FULL), the value of SGcod Multiple component transformation type would be 0.**

**PS3.3 may constrain the values of Photometric Interpretation for specific IODs.**

4. Despite the application of a multi-component color transformation and its reflection in the Photometric Interpretation attribute, the "color space" remains undefined. There is currently no means of conveying "standard color spaces" either by fixed values (such as sRGB) or by ICC profiles. Note in particular that the JP2 file header is not sent in the JPEG 2000 bitstream that is encapsulated in DICOM.

5. **If JPEG 2000 Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR\_ICT or YBR\_RCT to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.**

The JPEG 2000 bitstream is capable of encoding both signed and unsigned pixel values, hence the value of Pixel Representation (0028,0103) may be either 0 or 1 depending on what has been encoded (as specified in the SIZ marker segment in the precision and sign of component parameter).

The value of Planar Configuration (0028,0006) is irrelevant since the manner of encoding components is specified in the JPEG 2000 standard, hence it shall be set to 0.

## 8.2.5 MPEG2 MP@ML Image Compression

The use of the DICOM Encapsulated Format to support MPEG2 MP@ML compressed pixel data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream, with some specific exceptions noted here. The Pixel Data characteristics included in the MPEG2 MP@ML bit stream shall be used to decode the compressed data stream.

### Note

These requirements are specified in terms of consistency with what is encapsulated, rather than in terms of the uncompressed pixel data from which the compressed data stream may have been derived.

When decompressing, should the characteristics explicitly specified in the compressed data stream be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed Data Set might be encoded.

The MPEG2 MP@ML bit stream specifies whether or not a reversible or irreversible multi-component (color) transformation, if any, has been applied. If no multi-component transformation has been applied, then the components shall correspond to those specified by the DICOM Attribute Photometric Interpretation (0028,0004). MPEG2 MP@ML applies an irreversible multi-component transformation, so DICOM Attribute Photometric Interpretation (0028,0004) shall be YBR\_PARTIAL\_420 in the case of multi-component data, and MONOCHROME2 in the case of single component data (even though the MPEG2 bit stream itself is always encoded as three components, one luminance and two chrominance).

### Note

- If MPEG2 Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR\_PARTIAL\_420 to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.**
- MPEG2 proposes some video formats. Each of the standards specified is used in a different market, including: ITU-R BT.470-2 System M for SD NTSC and ITU-R BT.470-2 System B/G for SD PAL/SECAM. A PAL based system should therefore be based on ITU-BT.470 System B for each of Color Primaries, Transfer Characteristic (gamma) and matrix coefficients and should take a value of 5 as defined in ???.

## 8.2.6 MPEG2 MP@HL Image Compression

The use of the DICOM Encapsulated Format to support MPEG2 MP@HL compressed pixel data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream, with some specific exceptions noted here. The Pixel Data characteristics included in the MPEG2 MP@HL bit stream shall be used to decode the compressed data stream.

**Note**

These requirements are specified in terms of consistency with what is encapsulated, rather than in terms of the uncompressed pixel data from which the compressed data stream may have been derived.

When decompressing, should the characteristics explicitly specified in the compressed data stream be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed Data Set might be encoded.

**Note**

**If MPEG2 Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR\_PARTIAL\_420 to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.**

The requirements are:

- Planar Configuration (0028,0006) shall be 0

**Note**

The value of Planar Configuration (0028,0006) is irrelevant since the manner of encoding components is specified in the MPEG2 standard, hence it is set to 0.

- Samples per Pixel (0028,0002) shall be 3
- Photometric Interpretation (0028,0004) shall be YBR\_PARTIAL\_420 or MONOCHROME2
- ...

## 8.2.7 MPEG-4 AVC/H.264 HiP@Level4.1 Video Compression

The use of the DICOM Encapsulated Format to support MPEG-4 AVC/H.264 compressed pixel data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream, with some specific exceptions noted here. The Pixel Data characteristics included in the MPEG-4 AVC/H.264 bit stream shall be used to decode the compressed data stream.

**Note**

These requirements are specified in terms of consistency with what is encapsulated, rather than in terms of the uncompressed pixel data from which the compressed data stream may have been derived.

When decompressing, should the characteristics explicitly specified in the compressed data stream be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed Data Set might be encoded.

**Note**

**If MPEG-4 Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR\_PARTIAL\_420 to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.**

The requirements are:

- Planar Configuration (0028,0006) shall be 0
- Samples per Pixel (0028,0002) shall be 3
- Photometric Interpretation (0028,0004) shall be YBR\_PARTIAL\_420

## 8.2.8 MPEG-4 AVC/H.264 HiP@Level4.2 Video Compression

The use of the DICOM Encapsulated Format to support MPEG-4 AVC/H.264 compressed pixel data requires that the Data Elements that are related to the Pixel Data encoding (e.g. Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream, with some specific exceptions noted here. The Pixel Data characteristics included in the MPEG-4 AVC/H.264 bit stream shall be used to decode the compressed data stream.

### Note

These requirements are specified in terms of consistency with what is encapsulated, rather than in terms of the uncompressed pixel data from which the compressed data stream may have been derived.

When decompressing, should the characteristics explicitly specified in the compressed data stream be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed data set might be encoded.

### Note

**If MPEG-4 Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR\_PARTIAL\_420 to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.**

The requirements are:

- Planar Configuration (0028,0006) shall be 0
- Samples per Pixel (0028,0002) shall be 3
- Photometric Interpretation (0028,0004) shall be YBR\_PARTIAL\_420

## 8.2.9 MPEG-4 AVC/H.264 Stereo HiP@Level4.2 Video Compression

*For reference, from DICOM PS3.3:*

## A.8.5.4 Multi-frame True Color SC Image IOD Content Constraints

- Samples per Pixel (0028,0002) shall be 3

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- 1 • Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed transfer syntaxes that do not involve  
2 color space transformations, YBR\_ICT for irreversible JPEG 2000 transfer syntaxes, YBR\_RCT for reversible JPEG 2000 transfer  
3 syntaxes, YBR\_PARTIAL\_420 for MPEG2 and MPEG-4 AVC/H.264 transfer syntaxes and YBR\_FULL\_422 for other lossy compressed  
4 transfer syntaxes

5 **Note**

6 Future lossless and lossy transfer syntaxes may lead to the need for new definitions and choices for Photometric Interpret-  
7 ation.