DICOM Correction Proposal

STATUS	Assigned
Date of Last Update	2018/11/09
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Submission Date	2018/05/23

Correction Number CP-1835
Log Summary: Use TID for Quantity Definition
Name of Standard PS3.3, PS3.16 Edition 2019a
Rationale for Correction: Real-World value units are expressed by the Rescale Type (0028,1054) attribute or Measurement Units Code Sequence (0040,08EA) in the Real-World Mapping Macro. However, there are variances in terms of definition of some units which result in uncertainties when a a unit specifier is the only value provided. The following are two examples relevant for current proceedings. In the context of Sup 188 (Multi-Energy CT) new units have been proposed. Amongst others, Effective Atomic Number, has been proposed. However, there are various formulas how these values are defined. Further on, in the same context (though not in the supplement itself) the Stopping Power Ratio (SPR) has been propose as a unit as well. While SPR is well-defined, the value is dependent on the energy for what it is specified. Values of such units are used in calculations of therapeutic dose for Radiotherapy Ion treatments. Without a dependable specification, they are not usable as is, but will need further calibration, depending on the applications having determined them. To increase the level of reliability needed for safe dose calculation, the capability to annotate specific characterization of the understanding of unit is added. *WG-06 June 2018: Already covered by Quantity Definition Sequence (0040,9220), which is present in all images. However, use CP to add TID for already known units where needed.* *U. Busch: Codes ccc1 and ccc2 may have been introduced by Sup 147 already as codes (S147154, 99SUP147, "Relative Linear Stopping Power") and (S147155, 99SUP147, "Reference Energy").* *(U. Busch: Note: sample in PS3.17, EEEE.1 Encoding Diffusion Model Parameters for Parametric Maps)*
Correction Wording:

Make the following changes to PS3.3, Annex C:

C.7.6.16.2.11 Real World Value Mapping Macro

Table C.7.6.16-12 specifies the Attributes of the Real World Value Mapping Functional Group Macro.

Table C.7.6.16-12. Real World Value Mapping Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Real World Value Mapping Sequence	(0040,9096)	1	The mapping of stored values to associated Real World values. One or more Items shall be included in this Sequence.
>Include Table C.7.6.16-12b "Real World Value Mapping Item Macro Attributes"			*Defined CID for Measurement Units Code Sequence is 82, or as specified in the Macro invocation.*

Table C.7.6.16-12b. Real World Value Mapping Item Macro Attributes

Attribute Name	Tag	Type	Attribute Description
…			
Real World Value Intercept	(0040,9224)	1C	The Intercept value in relationship between stored values (SV) and the Real World values. See Section C.7.6.16.2.11.1.2 for further explanation. Required if Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are present or Real World Value LUT Data (0040,9212) is not present.
Real World Value Slope	(0040,9225)	1C	The Slope value in relationship between stored values (SV) and the real world values. See Section C.7.6.16.2.11.1.2 for further explanation. Required if Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are present or Real World Value LUT Data (0040,9212) is not present.
…			
Measurement Units Code Sequence	(0040,08EA)	1	Units of measurement. Only a single Item shall be included in this Sequence. See Section C.7.6.16.2.11.1 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Defined CID 7181 "Abstract Multi-dimensional Image Model Component Units", or as specified in the Macro invocation.*
>>Measurement Units Specialization Sequence	(xxxx,yyy2)	3	Parameters to further specify the exact interpretation of the unit specified by the Rescale Type (0028,1054). See C.7.6.16.2.11.1.X.
>>Include Table 10-2 "Content Item Macro Attributes"			*Baseline TID ttt1.*
Quantity Definition Sequence	(0040,9220)	3	A list of name-value pairs that describe the characteristics of the quantity represented by the Real World Value. One or more Items are permitted in this Sequence. ~~**One of the Items shall have a concept name that specifies the quantified characteristic, though it is not required that (G-C1C6, SRT, "Quantity") be used if there is a reason to use a similar concept from a different coding scheme. Other Items may**~~

Attribute Name	Tag	Type	Attribute Description
			~~be concept modifiers, such as (G-C036, SRT, "Measurement Method"). The order of the Items is not significant.~~
>Include Table 10-2 "Content Item Macro Attributes Description"			~~Baseline CID for Concept Name Code Sequence is CID 9000 "Physical Quantity Descriptors".~~ ~~Baseline CID for Concept Code Sequence for Concept Name of (G-C1C6, SRT, "Quantity") is CID 7180 "Abstract Multi-dimensional Image Model Component Semantics"~~. **Defined TID is TID ttt1 "Real-World Quantity Definition"**

C.7.6.16.2.11.1 Real World Value Representation

…

C.7.6.16.2.11.1.2 Real World Values Mapping Sequence Attributes

The Real World Value First Value Mapped (0040,9216) and Real World Value Last Value Mapped (0040,9211) Attributes describe the range of stored pixel values that are mapped by the Sequence Item. Stored pixel values less than the first value mapped, or greater than the last value mapped have no real value attached.

When the Real World Value Intercept (0040,9224) and Real World Value Slope (0040,9225) Attributes are supplied, the stored value (SV) is converted to a real world value (RV) using the equation:

RV = (Real World Value Slope) * SV + Real World Value Intercept

…

C.8.2.1 CT Image Module

The table in this Section contains IOD Attributes that describe CT images.

Table C.8-3. CT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.2.1.1.1 for specialization.
…			
Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV+b If Image Type (0008,0008) Value 1 is ORIGINAL and Value 3 is not LOCALIZER, output units shall be Hounsfield Units (HU).
Rescale Slope	(0028,1053)	1	m in the equation specified in Rescale Intercept (0028,1052).
Rescale Type	(0028,1054)	1C	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for Defined Terms and further explanation.

Attribute Name	Tag	Type	Attribute Description
			Required if the Rescale Type is not HU (Hounsfield Units). May be present otherwise.
Quantity Definition Sequence	**(0040,9220)**	**3**	**((TODO: Follow text in C.7.6.16-12b))**
>Include Table 10-2 "Content Item Macro Attributes Description"			**((TODO: Follow text in C.7.6.16-12b))**
…			

C.8.6.3 SC Multi-frame Image Module

Table C.8-25b contains IOD Attributes that describe SC Multi-frame images.

Table C.8-25b. SC Multi-frame Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the ….image was acquired. Enumerated Values: **YES** **NO**
…			
Rescale Intercept	(0028,1052)	1C	The value b in the relationship between stored values (SV) in Pixel Data (7FE0,0010) and the output units specified in Rescale Type (0028,1054). Output units = m*SV + b. Required if Photometric Interpretation (0028,0004) is MONOCHROME2, and Bits Stored (0028,0101) is greater than 1. Note This specifies an identity Modality LUT transformation.
Rescale Slope	(0028,1053)	1C	m in the equation specified by Rescale Intercept (0028,1052). Required if Photometric Interpretation (0028,0004) is MONOCHROME2, and Bits Stored (0028,0101) is greater than 1. Note This specifies an identity Modality LUT transformation.
Rescale Type	(0028,1054)	1C	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). Defined Terms: **US** Unspecified Required if Photometric Interpretation (0028,0004) is MONOCHROME2, and Bits Stored (0028,0101) is greater than 1. Note This specifies an identity Modality LUT transformation.

Attribute Name	Tag	Type	Attribute Description
Quantity Definition Sequence	**(0040,9220)**	**3**	**((TODO: Follow text in C.7.6.16-12b))**
>Include Table 10-2 "Content Item Macro Attributes Description"			**((TODO: Follow text in C.7.6.16-12b))**
Frame Increment Pointer	(0028,0009)	1C	Contains the Data Element Tag of the Attribute that is used as the frame increment in Multi-frame pixel data. See Section C.7.6.6.1.2 for further explanation. Shall be present if Number of Frames is greater than 1, overriding (specializing) the Type 1 requirement on this Attribute in the Multi-frame Module.
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C.8.11.3 DX Image Module

Table C.8-70 contains IOD Attributes that describe a DX Image by specializing Attributes of the General Image Module and Image Pixel Module, and adding additional Attributes.

Table C.8-70. DX Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.11.3.1.1 for specialization.
…			
Rescale Intercept	(0028,1052)	1	The value b in the relationship between stored values (SV) in Pixel Data (7FE0,0010) and the output units specified in Rescale Type (0028,1054). Output units = m*SV + b. Enumerated Values: See Section C.8.11.3.1.2 for further explanation.
Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052). Enumerated Values: See Section C.8.11.3.1.2 for further explanation.
Rescale Type	(0028,1054)	1	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). Enumerated Values: **US** Unspecified See Section C.8.11.3.1.2 for further explanation.
Quantity Definition Sequence	**(0040,9220)**	**3**	**((TODO: Follow text in C.7.6.16-12b))**
>Include Table 10-2 "Content Item Macro Attributes Description"			**((TODO: Follow text in C.7.6.16-12b))**

Attribute Name	Tag	Type	Attribute Description
…			

C.8.15.3.10 CT Pixel Value Transformation Macro

Table C.8-126 specifies the Attributes of the CT Pixel Value Transformation Functional Group Macro.

Note

1. This Macro is equivalent to the Modality LUT transformation in non Multi-frame IODs.
2- This in effect specializes the Section C.7.6.16.2.9 Pixel Value Transformation Macro.

Table C.8-126. CT Pixel Value Transformation Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Value Transformation Sequence	(0028,9145)	1	Contains the Attributes involved in the transformation of stored pixel values. Only a single Item shall be included in this Sequence.
>Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV + b.
>Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052).
>Rescale Type	(0028,1054)	1	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for further explanation. If Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Frame Type (0008,9007) Value 3 is not LOCALIZER, the value shall be HU (Hounsfield Units).
>Quantity Definition Sequence	**(0040,9220)**	**3**	**((TODO: Follow text in C.7.6.16-12b))**
>>Include Table 10-2 "Content Item Macro Attributes Description"			**((TODO: Follow text in C.7.6.16-12b))**

C.11.1 Modality LUT Module

Table C.11-1 specifies the Attributes that describe the Modality LUT.

Either a Modality LUT Sequence containing a single Item or Rescale Slope and Intercept values shall be present but not both.

Note

This requirement for only a single transformation makes it possible to unambiguously define the input of succeeding stages of the grayscale pipeline such as the VOI LUT.

Table C.11-1. Modality LUT Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.11-1b "Modality LUT Macro Attributes"			

Table C.11-1b. Modality LUT Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Modality LUT Sequence	(0028,3000)	1C	Defines a Sequence of Modality LUTs. Only a single Item shall be included in this Sequence. Shall not be present if Rescale Intercept (0028,1052) is present.
>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data in this Sequence. See Section C.11.1.1 for further explanation.
>LUT Explanation	(0028,3003)	3	Free form text explanation of the meaning of the LUT.
>Modality LUT Type	(0028,3004)	1	Specifies the output values of this Modality LUT. See Section C.11.1.1.2 for further explanation.
>LUT Data	(0028,3006)	1	LUT Data in this Sequence.
Rescale Intercept	(0028,1052)	1C	The value b in relationship between stored values (SV) and the output units specified in Rescale Type (0028,1054). Output units = m*SV + b. Required if Modality LUT Sequence (0028,3000) is not present. Shall not be present otherwise.
Rescale Slope	(0028,1053)	1C	m in the equation specified by Rescale Intercept (0028,1052). Required if Rescale Intercept is present.
Rescale Type	(0028,1054)	1C	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for further explanation. Required if Rescale Intercept is present.
Quantity Definition Sequence	**(0040,9220)**	**3**	**((TODO: Follow text in C.7.6.16-12b))**
>Include Table 10-2 "Content Item Macro Attributes Description"			**((TODO: Follow text in C.7.6.16-12b))**

C.11.1.1 LUT Attribute Descriptions

…

C.11.1.1.2 Modality LUT and Rescale Type

Specifies the units of the output of the Modality LUT or rescale operation.

Defined Terms:

OD The number in the LUT represents thousands of optical density. That is, a value of 2140 represents an optical density of 2.140.

HU Hounsfield Units (CT)

US Unspecified

Other values are permitted, but are not defined by the DICOM Standard.

Add the code ccc1 to CID 7180 the table in PS3.16, Annex B:

CID 7180 Abstract Multi-dimensional Image Model Component Semantics

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML
Type: Extensible
Version: yyyymmdd
UID: 1.2.840.10008.6.1.917

Table CID 7180. Abstract Multi-dimensional Image Model Component Semantics

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-CT Concept ID	UMLS Concept Unique ID	Units
DCM	ccc1	Relative Linear Stopping Power			EV (MeV, UCUM, "Megaelectronvolt")

Add the following to the table in PS3.16, Annex C:

TID TTT1 REAL-WORLD QUANTITY DEFINITION

TID ttt1
Real-World Quantity Definition
Type: Extensible Order: Non-Significant

	Value Type	Concept Name	VM	Req Type	Condition	Value Set Constraint
1	CODE	DT (246205007, SCT, "Quantity")	1	M		BCID 7180 "Abstract Multi-dimensional Image Model Component Semantics".
2	CODE	BCID 9000 "Physical Quantity Descriptors"	1-n	U		
3	NUMERIC	EV (DCM, ccc2, "Reference Energy")	1	MC	IF Row 1 Quantity value is (ccc1, 99SUP147, "Relative Linear Stopping Power ")	UNITS = EV ("MeV", UCUM, "Megaelectronvolt")

Content Item Descriptions

Row 1	One of the Items shall have a concept name that specifies the quantified characteristic, though it is not required that (246205007, SCT, "Quantity") be used if there is a reason to use a similar concept from a different coding scheme.
Row 2	Additional Items may be concept modifiers, such as (370129005, SCT, "Measurement Method").

Add the following to the table in PS3.16, Annex D:

ANNEX D DICOM CONTROLLED TERMINOLOGY DEFINITIONS (NORMATIVE)

Code Value	Code Meaning	Definition	Notes
ccc1	Relative Linear Stopping Power	Ratio of the linear stopping power of a material to the linear stopping power of water.	
ccc2	Reference Energy	An energy value which qualifies a quantity or parameter whose value is defined in respect to this energy.	