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8	Correction Number CP-1525	
9	Log Summary: Water equivalent diameter for CT RDSR	
10	Name of Standard	
11	PS3.3, PS3.6, PS3.16	
12	Rationale for Correction:	
13	CP 1170 added the AAPM TG 204 Size Specific Dose Estimate (SSDE) information to the CT RDSR template, using effective	
14	diameters based on linear measurements. SSDE has been quickly adopted, e.g., by the ACR Dose Index registry. AAPM TG 220	
15	reports the use of a more robust estimate of patient diameter based on attenuation, referred to as "Water Equivalent Diameter" (Dw),	
16	which may be used to produced an improved SSDE.	
17	As TG 220 describes, Dw may be computed and recorded per (reconstructed) slice, or an appropriately selected (e.g., mid-scan)	
18	value may be used, with similar results (the latter method being simpler). Both methods need to be supported by the DICOM standard,	
19	hence it is proposed that Dw per slice be added to the CT images and that representative Dw be added to the RDSR, together with	
20	new coded concepts describing these methods of SSDE calculation.	
21	Correction Wording:	

Amend both DICOM PS3.3 and PS 3.16 to add AAPM TG220 report to Normative References:

2 Normative References

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2.6 Other References

[AAPM Report 220] American Association of Physicists in Medicine. September 2014. *Report of AAPM Task Group 220 - Use of Water Equivalent Diameter for Calculating Patient Size and Size-Specific Dose Estimates (SSDE) in CT*. http://www.aapm.org/pubs/reports/rpt_220.pdf.

Amend DICOM PS 3.3 to add Dw per slice to CT Image Module for legacy CT image IOD:

C.8.2.1 CT Image Module

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Table C.8-3. CT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
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CTDIvol	(0018,9345)	3	Computed Tomography Dose Index (CTDI _{vol}), in mGy according to IEC 60601-2-44, Ed.2.1 (Clause 29.1.103.4), The Volume CTDI _{vol} . It describes the average dose for this image for the selected CT conditions of operation.
CTDI Phantom Type Code Sequence	(0018,9346)	3	The type of phantom used for CTDI measurement according to IEC 60601-2-44. Only a single Item is permitted in this Sequence.
>Include Table_8.8-1 "Code Sequence Macro Attributes"			Defined CID 4052 "Phantom Devices".
Water Equivalent Diameter	(0018,eee1)	3	The diameter of a cylinder of water having the same X-Ray attenuation as the patient for this reconstructed slice, in mm (e.g., as described in [AAPM Report 220]).
Water Equivalent Diameter Method Code Sequence	(0018,eee2)	1C	The method of calculation of Water Equivalent Diameter (0018,eee1). Required if Water Equivalent Diameter (0018,eee1) is present. Only a single Item is permitted in this Sequence.
>Include Table_8.8-1 "Code Sequence Macro Attributes"			Defined CID ccc1 "Water Equivalent Diameter Method".

Amend DICOM PS 3.3 to add Dw per slice to CT Exposure Macro for Enhanced CT Image IOD:

C.8.15.3.8 CT Exposure Macro

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Table C.8-124. CT Exposure Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Exposure Sequence	(0018,9321)	1	Contains the attributes defining exposure information. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
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>CTDIvol	(0018,9345)	2C	Computed Tomography Dose Index (CTDI _{vol}), in mGy according to IEC 60601-2-44, Ed.2.1 (Clause 29.1.103.4), The Volume CTDI _{vol} . It describes the average dose for this frame for the selected CT conditions of operation. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>CTDI Phantom Type Code Sequence	(0018,9346)	3	The type of phantom used for CTDI measurement according to IEC 60601-2-44. Only a single Item is permitted in this Sequence.
>>Include Table_8.8-1 "Code Sequence Macro Attributes"			Defined CID 4052 "Phantom Devices".
>Water Equivalent Diameter	(0018,eee1)	3	The diameter of a cylinder of water having the same X-Ray attenuation as the patient for this reconstructed slice, in mm (e.g., as described in [AAPM Report 220]).
Water Equivalent Diameter Method Code Sequence	(0018,eee2)	1C	The method of calculation of Water Equivalent Diameter (0018,eee1). Required if Water Equivalent Diameter (0018,eee1) is present. Only a single Item is permitted in this Sequence.
>Include Table_8.8-1 "Code Sequence Macro Attributes"			Defined CID ccc1 "Water Equivalent Diameter Method".

Amend DICOM PS 3.16 to add new concepts to CT Irradiation Event Data and included templates:

TID 10013 CT Irradiation Event Data

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Table TID 10013. CT Irradiation Event Data

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (113819, DCM, "CT Acquisition")	1	M		
...
7	>	CONTAINS	CONTAINER	EV (113822, DCM, "CT Acquisition Parameters")	1	M		
8	>>	CONTAINS	NUM	EV (113824, DCM, "Exposure Time")	1	M		UNITS = EV (s, UCUM, "s")
9	>>	CONTAINS	INCLUDE	DTID 10014 "Scanning Length"	1	M		
...
30	>>	CONTAINS	NUM	EV (113930, DCM, "Size Specific Dose Estimation")	1-n	U		UNITS = EV (mGy, UCUM, "mGy")
31	>>>	HAS CONCEPT MOD	CODE	EV (G-C036, SRT, "Measurement Method")	1	M		DCID 10023 "Size Specific Dose Estimation Method for CT"

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
32	>>>>	INFERRED FROM	NUM	EV (113931, DCM, "Measured Lateral Dimension")	1	MC	IF row 31 equals (113934, DCM, "AAPM 204 Lateral Dimension") or (113936, DCM, "AAPM 204 Sum of Lateral and AP Dimension")	UNITS = EV (mm, UCUM, "mm")
33	>>>>	INFERRED FROM	NUM	EV (113932, DCM, "Measured AP Dimension")	1	MC	IF row 31 equals (113935, DCM, "AAPM 204 AP Dimension") or (113936, DCM, "AAPM 204 Sum of Lateral and AP Dimension")	UNITS = EV (mm, UCUM, "mm")
34	>>>>	INFERRED FROM	NUM	EV (113933, DCM, "Derived Effective Diameter")	1	MC	IF row 31 equals (113934, DCM, "AAPM 204 Lateral Dimension") or (113935, DCM, "AAPM 204 AP Dimension") or (113936, DCM, "AAPM 204 Sum of Lateral and AP Dimension") or (113937, DCM, "AAPM 204 Effective Diameter Estimated From Patient Age")	UNITS = EV (mm, UCUM, "mm")
<u>34b</u>	<u>>>>></u>	<u>INFERRED FROM</u>	<u>NUM</u>	<u>EV (ddd001, DCM, "Water Equivalent Diameter")</u>	<u>1</u>	<u>MC</u>	<u>IF row 31 equals (ddd002, DCM, "Water Equivalent Diameter Representative Value")</u>	<u>UNITS = EV (mm, UCUM, "mm")</u>
<u>34c</u>	<u>>>>>></u>	<u>HAS CONCEPT MOD</u>	<u>CODE</u>	<u>EV EV (G-C036, SRT, "Measurement Method")</u>	<u>1</u>	<u>M</u>		<u>DCID ccc1 "Water Equivalent Diameter Method"</u>
<u>34d</u>	<u>>>>></u>	<u>INFERRED FROM</u>	<u>UIDREF</u>	<u>EV (ddd010, DCM, "Series or Instance used for Water Equivalent Diameter estimation")</u>	<u>1-n</u>	<u>MC</u>	<u>IF row 31 equals (ddd003, DCM, "Water Equivalent Diameter Integrated Across Scan Range") or (ddd005, DCM, "Water Equivalent Diameter From Localizer") or (row 31 equals (ddd004, DCM, "Water Equivalent Diameter From Raw Data") and the Raw Data is encoded in DICOM).</u>	
<u>34e</u>	<u>>>>></u>	<u>INFERRED FROM</u>	<u>NUM</u>	<u>EV (ddd020, DCM, "Z value of location of Water Equivalent Diameter estimation")</u>	<u>1</u>	<u>MC</u>	<u>IF row 31 equals (ddd002, DCM, "Water Equivalent Diameter Representative Value")</u>	<u>UNITS = EV (mm, UCUM, "mm")</u>
35	>>	CONTAINS	INCLUDE	DTID 10015 CT Dose Check Details	1	M		
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Content Item Descriptions

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1 2	Row 30	More than one Size Specific Dose Estimation may be included, for example if different computation methods are used.
3 4 5 6	Row 31	The methods of AAPM Report 204 are listed in CID 10023 "Size Specific Dose Estimation Method for CT"; other methods may be used. The phantom size (16cm or 32cm) used for the calculation is available from the phantom type defined in Row 23.
7	Row 32	The condition specifies inclusion of the Measured Lateral Dimension if it was used in the calculation.
8	Row 33	The condition specifies inclusion of the Measured AP Dimension if it was used in the calculation.
9 10	Row 34	The Derived Effective Diameter is conditionally included, whether it was derived from measurements or estimated from age, but may not be used for other (non-AAPM Report 204) methods.
11 12 13	Row 34b	<u>A single value for Water Equivalent Diameter is encoded in Row 34b if the method uses a single value. It is required if the method uses a representative slice, but may also be present if the method used a Localizer or Raw Data at a single location rather than the entire scan range.</u>
14 15 16	Row 34c	<u>The modifier is intended to specify the family of methods and not the specific technique (e.g., for AAPM 220 (ddd031, DCM, "AAPM 220") is used, not (ddd002, DCM, "Water Equivalent Diameter Representative Value"), etc.).</u>
17 18 19 20 21	Row 34d	<u>If the method uses multiple slices across the scan range, the reconstructed image Series or (list of) Instances used is referenced; the values for Water Equivalent Diameter may or may not be recorded in the CT Image Module or CT Exposure Macro of those images. More than one Series may be referenced if the reconstructed images for this acquisition used for Water Equivalent Diameter estimation span multiple series.</u> <u>If the Water Equivalent Diameter was computed from raw views rather than reconstructed images, then the Raw Data is referenced, if it was encoded in DICOM (it is not required to be).</u>
22 23 24 25 26 27 28	Row 34e	<u>This location is patient (not table or gantry) relative, to allow it to be defined in the Patient Coordinate System and hence related to the Image Position (Patient) in the reconstructed images (see TID 10014 "Scanning Length", included at Row 9). It is required if the method uses a representative slice, but may also be present if the method used a Localizer or Raw Data at a single location rather than the entire scan range.</u>
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TID 10014 Scanning Length

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Table TID 10014. Scanning Length

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
33 34 35 36	1		NUM	EV (113825, DCM, "Scanning Length")	1	M		UNITS = EV (mm, UCUM, "mm")
37
38 39 40 41	8		UIDREF	EV (112227, DCM, "Frame of Reference UID")	1	MC	IF any of Rows 4 through 7 or Row 34e of TID 10013 are present.	If present, shall be the same UID as in the images reconstructed from this irradiation event.

Amend DICOM PS 3.16 to add new concepts to context groups:

CID 10023 Size Specific Dose Estimation Method for CT

Type: Extensible
Version: 20120471yyymmdd

Table CID 10023. Size Specific Dose Estimation Method for CT

Coding Scheme Designator	Code Value	Code Meaning
DCM	113934	AAPM 204 Lateral Dimension
DCM	113935	AAPM 204 AP Dimension
DCM	113936	AAPM 204 Sum of Lateral and AP Dimension
DCM	113937	AAPM 204 Effective Diameter Estimated From Patient Age
<u>DCM</u>	<u>ddd002</u>	<u>Water Equivalent Diameter Representative Value</u>
<u>DCM</u>	<u>ddd003</u>	<u>Water Equivalent Diameter Integrated Across Scan Range</u>
<u>DCM</u>	<u>ddd004</u>	<u>Water Equivalent Diameter From Raw Data</u>
<u>DCM</u>	<u>ddd005</u>	<u>Water Equivalent Diameter From Localizer</u>

Add to DICOM PS 3.16 new context group:

CID ccc1 Water Equivalent Diameter Method

Type: Extensible
Version: yyyymmdd

Table CID ccc1. Water Equivalent Diameter Method

Coding Scheme Designator	Code Value	Code Meaning
DCM	ddd031	AAPM 220

Amend DICOM PS 3.16 to add definitions for new concepts:

Table D-1. DICOM Controlled Terminology Definitions

Code Value	Code Meaning	Definition	Notes
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113930	Size Specific Dose Estimation	The Size-Specific Dose Estimate is a patient dose estimate that takes into account the size of the patient, such as described in AAPM Report 204 or AAPM Report 220 , by using linear dimensions measured on the patient or patient images or estimated from patient age.	
113931	Measured Lateral Dimension	The side-to-side (left to right) dimension of the body part being scanned (per AAPM Report 204).	
113932	Measured AP Dimension	The thickness of the body part being scanned, in the antero-posterior dimension (per AAPM Report 204).	
113933	Derived Effective Diameter	The diameter of the patient at a given location along the Z-axis of the patient, assuming that the patient has a circular cross-section (per AAPM Report 204).	
113934	AAPM 204 Lateral Dimension	The Size Specific Dose Estimation is computed using Table 1B (32cm phantom) or Table 2B (16cm phantom) of AAPM Report 204.	
113935	AAPM 204 AP Dimension	The Size Specific Dose Estimation is computed using Table 1C (32cm phantom) or Table 2C (16cm phantom) of AAPM Report 204.	
113936	AAPM 204 Sum of Lateral and AP Dimension	The Size Specific Dose Estimation is computed using Table 1A (32cm phantom) or Table 2A (16cm phantom) of AAPM Report 204.	
113937	AAPM 204 Effective Diameter Estimated From Patient Age	The Size Specific Dose Estimation is computed using Table 1D (32cm phantom) or Table 2D (16cm phantom) using an effective diameter estimated from the patient's age using Table 3 of AAPM Report 204.	

Code Value	Code Meaning	Definition	Notes
<u>ddd001</u>	<u>Water Equivalent Diameter</u>	<u>The diameter of a cylinder of water having the same X-Ray attenuation as the patient for a specified reconstructed slice, in mm (e.g., as described in [AAPM Report 220]).</u>	
<u>ddd002</u>	<u>Water Equivalent Diameter Representative Value</u>	<u>The Size Specific Dose Estimation is computed using a single representative value of Water Equivalent Diameter.</u> <u>E.g., computed as per AAPM Report 220 and used as the index into Table 1D (32cm phantom) or Table 2D (16cm phantom) of AAPM Report 204 (i.e., as described in the Appendix of AAPM Report 220).</u> <u>The single value used may be a mean of the values across the entire scan range, or may be a value at a single location sufficiently representative of the body region.</u>	
<u>ddd003</u>	<u>Water Equivalent Diameter Integrated Across Scan Range</u>	<u>The Size Specific Dose Estimation is computed using Water Equivalent Diameter values for a sample of slices across the entire scan range.</u> <u>E.g., computed as per AAPM Report 220 and used as the index into Table 1D (32cm phantom) or Table 2D (16cm phantom) of AAPM Report 204 (i.e., as described in the Appendix of AAPM Report 220).</u>	
<u>ddd004</u>	<u>Water Equivalent Diameter From Raw Data</u>	<u>The Size Specific Dose Estimation is computed using Water Equivalent Diameter values derived from Raw Data rather than reconstructed slices.</u> <u>E.g., used as the index into Table 1D (32cm phantom) or Table 2D (16cm phantom) of AAPM Report 204 (i.e., as described in the Appendix of AAPM Report 220).</u>	
<u>ddd005</u>	<u>Water Equivalent Diameter From Localizer</u>	<u>The Size Specific Dose Estimation is computed using Water Equivalent Diameter values derived from a Localizer image.</u> <u>E.g., used as the index into Table 1D (32cm phantom) or Table 2D (16cm phantom) of AAPM Report 204 (i.e., as described in the Appendix of AAPM Report 220).</u>	
<u>ddd010</u>	<u>Series or Instance used for Water Equivalent Diameter estimation</u>	<u>Unique identifier of the Series or Instance(s) used for Water Equivalent Diameter estimation, whether it be a Series of reconstructed single slice images or one or more Enhanced Multi-frame images or a Raw Data Series or Instance.</u>	
<u>ddd020</u>	<u>Z value of location of Water Equivalent Diameter estimation</u>	<u>The Z location used for Water Equivalent Diameter estimation at a single location whether it be computed using a reconstructed slice or Localizer or Raw Data. Specified as the Z component within the Patient Coordinate System defined by a specified Frame of Reference.</u>	
<u>ddd031</u>	<u>AAPM 220</u>	<u>A report describing methods of calculation of diameters of cylinders of water having the same X-Ray attenuation as reconstructed CT slices of patients described in [AAPM Report 220].</u>	

Amend DICOM PS 3.1 to add new data elements:

Table 6-1. Registry of DICOM Data Elements

Tag	Name	Keyword	VR	VM
<u>(0018,eee1)</u>	<u>Water Equivalent Diameter</u>	<u>WaterEquivalentDiameter</u>	<u>FD</u>	<u>1</u>
<u>(0018,eee2)</u>	<u>Water Equivalent Diameter Calculation Method Code Sequence</u>	<u>WaterEquivalentDiameter CalculationMethodCodeSequence</u>	<u>SQ</u>	<u>1</u>