DICOM Correction Item

Correction Number CP- 479	
Log Summary: CAD Rendering Intent Level	
Type of Modification Addition	Name of Standard PS 3.4, 3.16, 3.17 - 2004

Rationale for Correction:

Computer Aided Detection (CAD) algorithms can be performed at different operating points. The different operating points determine different levels of sensitivity and specificity. By documenting which Single Image Findings should be presented at each CAD operating point, the Mammography CAD SR and Chest CAD SR can annotate each finding so that the renderer can display a range of findings based on an operating point selected by the user of the rendering device. Particular note should be made of the fact that experience tells us that different radiologists want to operate at different CAD operating points. For that reason is would be undesireable to truncate the CAD SR objects by applying the operating point at the time of report creation.

This CP defines how a CAD device can specify the operating point number assigned to each Single Image Finding. Note that for compatibility with existing CAD SR objects, this technology only applies to Single Image Findings. SCPs are not required to use this logic, though it is desirable.

This capability is already present in commercial film-screen mammography CAD products and is projected to be required immediately in commercial digital mammography CAD products.

Sections of documents affected

PS 3.4 Annex O, PS 3.16 TID 4006, TID 4017 and TID 4104, Annex D, and PS 3.17 Annex E

Correction Wording:

See below.

Modify PS 3.4, Annex O

O.2 Behavior

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O.2.2.1 Mammography CAD SR and Chest CAD SR SOP Classes

The Mammography CAD SR and Chest CAD SR objects contain data not only for presentation to the clinician, but also data solely for use in subsequent mammography CAD analyses.

The SCU provides rendering guidelines via "Rendering Intent" concept modifiers associated with "Individual Impression/Recommendation", "Composite Feature" and "Single Image Finding" content items. The full meaning of the SR is provided if all content items marked "Presentation Required" are rendered down to the first instance of "Not for Presentation" or "Presentation Optional" for each branch of the tree. Use of the SCU's Conformance Statement is recommended if further enhancement of the meaning of the SR can be accomplished by rendering some or all of the data marked "Presentation Optional". Data marked "Not for Presentation" should not be rendered by the SCP; it is embedded in the SR content tree as input to subsequent Mammography CAD analysis work steps.

The SCP may further interpret whether or not to render a Single Image Finding that has Rendering Intent "Presentation Optional" by interpreting the value of the CAD Operating Point content item that is subordinate to the Rendering Intent, if present. If the CAD Operating Point content item is not present, then rendering of the Single Image Finding may be based on recommendations in the creator's DICOM Conformance Statement. For further information on the intended use of CAD Operating Point see PS 3.17, Mammography CAD (Informative) Annex, CAD Operating Point.

O.4 CONFORMANCE

In addition to the Conformance Statement requirements for the Storage Service Class specified in B.4.3, the following additional requirements are specified for Structured Reporting Storage SOP Classes:

O.4.1 Conformance Statement for an SCU

The following shall be documented in the Conformance Statement of any implementation claiming conformance to the Structured Reporting Storage SOP Classes as an SCU:

- The Image or other composite object Storage SOP Classes that are also supported by the SCU and which may be referenced by instances of Structured Reporting Storage SOP Class.
- The range of Value Types and Relationship Types that are supported by the SCU.
- The conditions under which a new SOP Instance UID is generated for an existing SR Document.

O.4.1.1 Mammography CAD SR and Chest CAD SR SOP Classes

The following shall be documented in the Conformance Statement of any implementation claiming conformance to the Mammography CAD SR SOP Class as an SCU:

- Which types of detections and/or analyses the device is capable of performing:
    - From detections listed in Context Group 6014 Mammography Single Image Finding
    - From analyses listed in Context Group 6043 Types of Mammography CAD Analysis

The following shall be documented in the Conformance Statement of any implementation claiming conformance to the Chest CAD SR SOP Class as an SCU:

- Which types of detections and/or analyses the device is capable of performing:
    - From detections listed in Context ID 6101 Chest Finding or Feature, or Context ID 6102 Chest Finding or Feature Modifier
    - From analyses listed in Context ID 6137 Types of Chest CAD Analysis

The following shall be documented in the Conformance Statement of any implementation claiming conformance to the Mammography CAD SR or Chest CAD SR SOP Class as an SCU **that creates instances**:

- Which optional content items are supported
- Conditions under which content items are assigned Rendering Intent of "Presentation Optional"**, and whether a CAD Operating Point value will be included with each Single Image Finding that has Rendering Intent of "Presentation Optional".**
- **Recommendations for the conditions under which content items with Rendering Intent of "Presentation Optional" should be rendered, based on CAD Operating Point or otherwise**.
- Conditions under which content items are assigned Rendering Intent of "Not for Presentation"

Modify PS 3.16, Annex A

TID 4006 Mammography CAD Single Image Finding Template

This template describes a single image finding for a lesion or other object. The details of the finding are expressed in this template and/or more specific templates. The details from which a single image Calcification Cluster is inferred may be expressed in a number of Single Image Findings (see TID 4006) of type Individual Calcification.

A Single Image Finding of type Breast Composition may be INFERRED FROM by-reference to a Single Image Finding of type Breast Geometry.

TID 4006
MAMMOGRAPHY CAD SINGLE IMAGE FINDING
Type: Non-Extensible

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CODE	EV(111059, DCM, "Single Image Finding")	1	M		DCID (6014) "Mammography Single Image Finding"
2	>	HAS CONCEPT MOD	CODE	EV(111056, DCM, "Rendering Intent")	1	M		DCID (6034) "Intended Use of CAD Output"
3	**>>**	**HAS PROPERTIES**	**NUM**	**(111071, DCM, "CAD Operating Point")**	**1**	**UC**	**IFF value of row 2 is (111151, DCM, "Presentation Optional") and row 9 of TID 4017 is present**	**UNITS = DT ({1:n}, UCUM, "range: 1:n"), where n is the maximum specified in Row 9 of TID 4017. Value is restricted to being an integer**
~~3~~4	>	HAS PROPERTIES	INCLUDE	DTID (4019) "CAD Algorithm Identification"	1	M		
~~4~~5	>	HAS PROPERTIES	NUM	EV(111012, DCM, "Certainty of Finding")	1	U		UNITS = EV(%, UCUM, "Percent") Value = 0 – 100

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
~~5~~6	>	HAS PROPERTIES	NUM	EV(111047, DCM, "Probability of cancer")	1	UC	May be present unless value of parent is (F-01710,SRT, "Breast composition"), (111100, DCM, "Breast geometry"), (T-04100, SNM3, "Nipple"), (111099, DCM, "Selected region"), (111101, DCM, "Image quality") or (111102, DCM, "Non-lesion")	UNITS = EV(%, UCUM, "Percent") Value = 0 – 100
~~6~~7	>	HAS PROPERTIES	INCLUDE	DTID (4021) "Mammography CAD Geometry"	1	MC	Shall be present unless value of parent is (F-01710,SRT, "Breast composition"), (111100, DCM, "Breast geometry") or (111101, DCM, "Image quality")	
~~7~~8	>	HAS PROPERTIES	INCLUDE	DTID (4007) "Mammography CAD Breast Composition"	1	MC	Shall be present only if value of parent is (F-01710,SRT, "Breast composition")	
~~8~~9	>	R-INFERRED FROM	CODE		1-n	UC	May be present only if value of parent is (F-01710,SRT, "Breast composition")	Shall reference a (111059, DCM, "Single Image Finding") of value: EV (111100, DCM, "Breast geometry")
~~9~~10	>	HAS PROPERTIES	INCLUDE	DTID (4008) "Mammography CAD Breast Geometry"	1	MC	Shall be present only if value of parent is (111100, DCM, "Breast geometry")	
~~10~~11	>	HAS PROPERTIES	INCLUDE	DTID (4009) "Mammography CAD Individual Calcification"	1	UC	May be present only if value of parent is (F-01776,SRT, "Individual Calcification")	
~~11~~12	>	HAS PROPERTIES	INCLUDE	DTID (4010) "Mammography CAD Calcification Cluster"	1	UC	May be present only if value of parent is (F-01775,SRT, "Calcification Cluster")	
~~12~~13	>	HAS PROPERTIES	INCLUDE	DTID (4011) "Mammography CAD Density"	1	UC	May be present only if value of parent is (F-01796,SRT,"Mammography breast density")	
~~13~~14	>	HAS PROPERTIES	CODE	EV(111297,DCM, "Nipple Characteristic")	1	UC	May be present only if value of parent is (T-04100, SNM3, "Nipple")	DCID (6039) "Nipple Characteristic"
~~14~~15	>	HAS PROPERTIES	INCLUDE	DTID (4012) "Mammography CAD Non-Lesion"	1	MC	Shall be present only if value of parent is (111102, DCM, "Non-lesion")	
~~15~~16	>	HAS PROPERTIES	INCLUDE	DTID (4013) "Mammography CAD Selected Region"	1	MC	Shall be present only if value of parent is (111099, DCM, "Selected Region")	
~~16~~17	>	R-INFERRED FROM	IMAGE		1	MC	Shall be present only if value of parent is (111101, DCM, "Image quality") and row ~~17~~18 is not present	Shall reference an IMAGE content item in the (111028, DCM, "Image Library")
~~17~~18	>	HAS PROPERTIES	SCOORD	EV(111030, DCM, "Image Region")	1-n	MC	Shall be present only if value of parent is (111101, DCM, "Image quality") and row ~~16~~17 is not present	
~~18~~19	>>	R-SELECTED FROM	IMAGE		1	M		All the (111030, DCM, "Image Region") content items in a single invocation of this template shall reference the same IMAGE content item in the (111028, DCM, "Image Library")

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
~~19~~2 0	>	HAS PROPERTIES	INCLUDE	DTID (4014) "CAD Image Quality"	1-n	MC	Shall be present only if value of parent is (111101, DCM, "Image quality")	$QualityFinding = DCID (6041) "Mammography Image Quality Finding", $QualityStandard = DCID (6045) "Mammography Types of Quality Control Standard"
~~20~~2 1	>	INFERRED FROM	INCLUDE	DTID (4006) "Mammography CAD Single Image Finding"	1-n	UC	May be present only if value of parent is (F-01775,SRT, "Calcification Cluster")	EV (F-01776,SRT, "Individual Calcification")
~~21~~2 2	>	HAS OBS CONTEXT	INCLUDE	DTID (4022) "CAD Observation Context"	1	MC	Shall be present only if this finding is incorporated from a different report than its parent.	

Content Item Descriptions

Rendering Intent	This content item constrains the SCP receiving the Mammography CAD SR IOD in its use of the contents of this template and its target content items. Mammography CAD devices may opt to use data marked "Not for Presentation" or "Presentation Optional" as input to subsequent mammography CAD processing steps. Refer to PS 3.4, Annex O Structured Reporting Storage SOP Classes for SCU and SCP Behavior.
CAD Operating Point	**Additional information to use when Rendering Intent is "Presentation Optional". A CAD Operating Point of zero is not sent, and is encoded as a Rendering Intent of "Presentation Required". See PS 3.4 section on Structured Reporting Storage SOP Classes for SCU and SCP Behavior and PS 3.17 annex on Mammography.**
Single Image Finding	A Single Image Finding (whose parent is a Single Image Finding of type Calcification Cluster) allows one level of nesting for the definition of individual calcifications within the cluster. To use this template recursively, this Single Image Finding code value shall be "Individual Calcification".
Certainty of Finding	The likelihood that the finding detected, and classified by the CODE specified in the Single Image Finding parent template, is in fact that type of finding.

TID 4017 CAD Detection Performed Template

This template fully identifies a detection algorithm and the images and/or image regions on which it operated (see TID 4015).

Parameter Name	Parameter Usage
$DetectionCode	Coded term or Context Group for Detection Performed

TID 4017
CAD DETECTION PERFORMED
Type: Non-Extensible

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CODE	EV(111022, DCM, "Detection Performed")	1	M		$DetectionCode
2	>	HAS PROPERTIES	INCLUDE	DTID (4019) "CAD Algorithm Identification"	1	M		
3	>	HAS PROPERTI	IMAGE		1-n	MC	At least one of row 3, 4, 5 or 6 shall be present	

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
		ES						
4	>	R-HAS PROPERTIES	IMAGE		1-n	MC	At least one of row 3,5 or 6 shall be present	Shall reference IMAGE content item(s) in the (111028, DCM, "Image Library")
5	>	HAS PROPERTIES	UIDREF	EV(112002,DCM,"Series Instance UID")	1-n	MC	At least one of row 3,5 or 6 shall be present	
6	>	HAS PROPERTIES	SCOORD	EV(111030, DCM, "Image Region")	1-n	MC	At least one of row 3,5 or 6 shall be present	
7		SELECTED FROM	IMAGE		1	MC	XOR row 8	
8	>>	R-SELECTED FROM	IMAGE		1	MC	XOR row 7	Shall reference an IMAGE content item in the (111028, DCM, "Image Library")
9	**>**	**HAS PROPERTIES**	**NUM**	**(111072, DCM, "Maximum CAD Operating Point")**	**1**	**U**		**UNITS = DT ([arb'U], UCUM, "arbitrary unit"),** **Value is restricted to being an integer**

Content Item Descriptions

CAD Algorithm Identification	If more than one detection algorithm has the same "Detection Performed" code value (e.g., CID 6014) then the "CAD Algorithm Identification" shall unambiguously distinguish between algorithms.
Rows 3 - 6	When this template is invoked for the Mammography CAD SR, the Image Library is mandatory, thus only row 4 and/or row 6 shall be present. When this template is invoked for the Chest CAD SR, the Image Library is optional, thus any combination of rows 3, 4, 5 and 6 may be present.
Rows 7 - 8	When this template is invoked for the Mammography CAD SR, the Image Library is mandatory, thus only row 8 shall be present. When this template is invoked for the Chest CAD SR, the Image Library is optional, thus row 7 or 8 may be present.
Maximum CAD Operating Point	**The maximum possible value of CAD Operating Point for this type of Detection Performed. No CAD Operating Point value recorded in the CAD Processing and Findings Summary sub-tree of the report for this type of Detection Performed shall exceed this value. The report may or may not contain Rendering Intent = "Presentation Optional" detections that are assigned the maximum value.**

TID 4104 Chest CAD Single Image Finding Template

This template describes a single image finding for a lesion or other object. The details of the finding are expressed in this template and/or more specific templates.

TID 4104
CHEST CAD SINGLE IMAGE FINDING
Type: Non-Extensible

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CODE	EV (111059, DCM, "Single Image Finding")	1	M		DCID (6101) Chest Finding or Feature
2	>	HAS CONCEPT	CODE	EV (112024, DCM, "Single Image Finding Modifier")	1	U		DCID (6102) Chest Finding or Feature Modifier

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
		MOD						
3	>	HAS CONCEPT MOD	TEXT	EV (112050, DCM, "Anatomic Identifier")	1	U		
4	>	HAS CONCEPT MOD	CODE	EV (112003, DCM, "Associated Chest Component")	1	MC	Shall be present IFF value of row 1 is (112005, DCM, "Radiographic anatomy")	DCID (6100) Chest Component Categories
5	>	HAS CONCEPT MOD	CODE	EV (112037, DCM, "Non-lesion Modifier")	1	UC	May be present IFF value of row 1 is (111102, DCM, "Non-lesion")	DCID (6139) Non-lesion Modifiers
6	>	HAS CONCEPT MOD	CODE	EV (111056, DCM, "Rendering Intent")	1	M		DCID (6034) Intended Use of CAD Output
7	**>>**	**HAS PROPERTIES**	**NUM**	**(111071, DCM, "CAD Operating Point")**	**1**	**UC**	**IFF value of row 6 is (111151, DCM, "Presentation Optional") and row 9 of TID 4017 is present**	**UNITS = DT ({1:n}, UCUM, "range: 1:n"), where n is the maximum specified in Row 9 of TID 4017. Value is restricted to being an integer**
~~7~~**8**	>	HAS OBS CONTEXT	INCLUDE	DTID (4108) Tracking Identifier	1	U		
~~8~~**9**	>	HAS OBS CONTEXT	CODE	EV (112016, DCM, "Baseline Category")	1	U		DCID (6145) Baseline Category
~~9~~**10**	>	HAS OBS CONTEXT	INCLUDE	DTID (4022) CAD Observation Context	1	MC	Shall be present IFF this finding is duplicated from a different report than its parent.	
~~10~~ **11**	>	HAS OBS CONTEXT	INCLUDE	DTID (4019) CAD Algorithm Identification	1	M		
~~11~~ **12**	>	HAS PROPERTIES	NUM	EV (111012, DCM, "Certainty of Finding")	1	U		UNITS = EV (%, UCUM, "Percent") Value = 0 – 100
~~12~~ **13**	>	HAS PROPERTIES	TEXT	EV (111058, DCM, "Selected Region Description")	1	MC	Shall be present IFF value of row 1 is (111099, DCM, "Selected region")	
~~13~~ **14**	>	HAS PROPERTIES	INCLUDE	DTID (4107) Chest CAD Geometry	1	MC	Shall be present unless value of row 1 is (111101, DCM, "Image quality")	
~~14~~ **15**	>	HAS PROPERTIES	INCLUDE	DTID (1400) Linear Measurement	1-n	U		
~~15~~ **16**	>	HAS PROPERTIES	INCLUDE	DTID (1401) Area Measurement	1-n	U		
~~16~~ **17**	>	HAS PROPERTIES	INCLUDE	DTID (1402) Volume Measurement	1-n	U		
~~17~~ **18**	>	HAS PROPERTIES	INCLUDE	DTID (4105) Chest CAD Descriptors	1	U		
~~18~~ **19**	>	INFERRED FROM	IMAGE		1	MC	Shall be present IFF value of row 1 is (111101, DCM, "Image quality") and rows ~~19~~**20** and 2~~0~~**1** are not present	
~~19~~ **20**	>	R-INFERRED FROM	IMAGE		1	MC	Shall be present IFF value of row 1 is (111101, DCM, "Image quality") and rows 1~~8~~**9** and 2~~0~~**1** are not present	Shall reference an IMAGE content item in the (111028, DCM, "Image Library")
~~20~~ **21**	>	INFERRED FROM	SCOORD	EV (111030, DCM, "Image Region")	1-n	MC	Shall be present IFF value of row 1 is (111101, DCM, "Image quality") and rows 1~~8~~**9** and	

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
							~~19~~20 are not present	
~~21~~ 22	>>	SELECTED FROM	IMAGE		1	MC	XOR row 2~~23~~	All the row 2~~01~~ content items in a single invocation of this template shall reference the same IMAGE
~~22~~ 23	>>	R-SELECTED FROM	IMAGE		1	MC	XOR row 2~~12~~	All the row 2~~01~~ content items in a single invocation of this template shall reference the same IMAGE content item in the (111028, DCM, "Image Library")
~~23~~ 24	>	HAS PROPERTIES	INCLUDE	DTID (4014) CAD Image Quality	1	MC	Shall be present IFF value of row 1 is (111101, DCM, "Image quality")	$QualityFinding = DCID (6135) Chest Image Quality Finding $QualityStandard = DCID (6136) Chest Types of Quality Control Standard

Content Item Descriptions

Anatomic Identifier	An identifier of an anatomic feature when a multiplicity of features of that type may be present, such as "Rib 1", "Rib 2" or thoracic ~~**vertibrae**~~ **vertebrae** "T1" or "T2".
Rendering Intent	This content item constrains the SCP receiving the Chest CAD SR IOD in its use of the contents of this template and its target content items. Chest CAD devices may opt to use data marked "Not for Presentation" or "Presentation Optional" as input to subsequent chest CAD processing steps. Refer to PS 3.4~~, Annex O~~ **section on** Structured Reporting Storage SOP Classes for SCU and SCP Behavior.
CAD Operating Point	**Additional information to use when Rendering Intent is "Presentation Optional". A CAD Operating Point of zero is not sent, and is encoded as a Rendering Intent of "Presentation Required". See PS 3.4 section on Structured Reporting Storage SOP Classes for SCU and SCP Behavior and PS 3.17 annex on Mammography.**
Certainty of Finding	The certainty of the CAD device that the finding detected and classified by the Single Image Finding CODE specified is in fact that type of finding.

Add to PS 3.16, Annex D

Code Value	Code Meaning	Definition	Notes
111071	**CAD Operating Point**	**One of a number of discrete points on the Receiver-Operator Characteristics (ROC) curve that reflects the expected sensitivity and specificity of a CAD algorithm, where zero indicates the highest specificity, lowest sensitivity operating point. The value should not exceed the Maximum CAD Operating Point.**	

111072	**Maximum CAD Operating Point**	**The maximum value of CAD Operating Point for the specific CAD algorithm used.**	

Add the following to PS 3.17, Annex E

E.4 CAD Operating Point

Computer-aided detection algorithms often compute an internal "CAD score" for each Single Image Finding detected by the algorithm. In some implementations the algorithms then group the findings into "bins" as a function of their CAD score. The number of bins is a function of the algorithm and the manufacturer's implementation, and must be one or more. The bins allow an application that is displaying CAD marks to provide a number of operating points on the Free-response Receiver-Operating Characteristic (FROC) curve for the algorithm, as illustrated in Figure E.4-1.

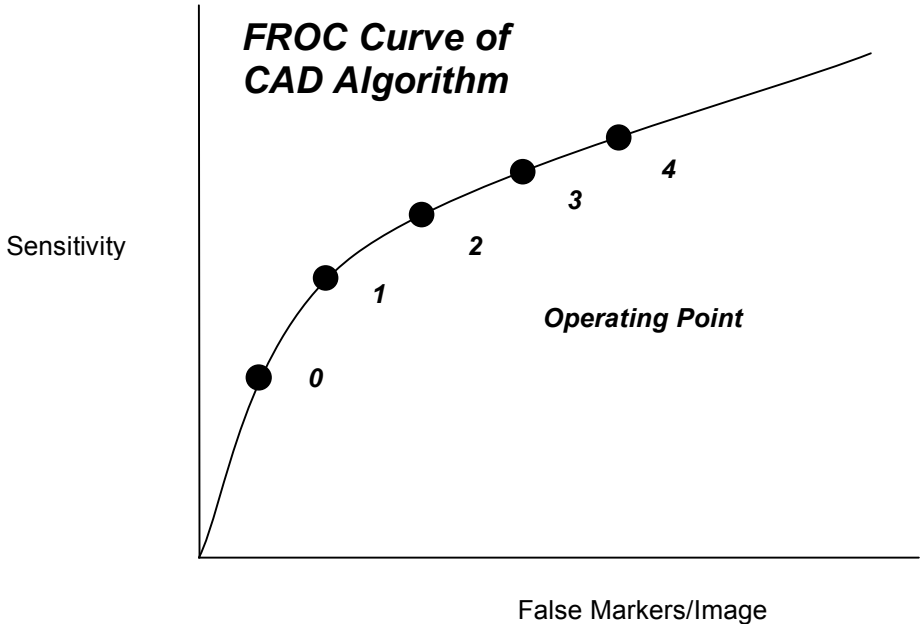

Figure E.4-1 - Free-response Receiver-Operating Characteristic (FROC) curve

This is accomplished by displaying all CAD marks of Rendering Intent "Presentation Required" or "Presentation Optional" according to the following rules:

- **if the display application's Operating Point is 0, only marks with a Rendering Intent = "Presentation Required" are displayed**
- **if the display application's Operating Point is 1, then marks with a Rendering Intent = "Presentation Required" and marks with a Rendering Intent = "Presentation Optional" with a CAD Operating Point = 1 are displayed**
- **if the display application's Operating Point is n, then marks with a Rendering Intent = "Presentation Required" and marks with a Rendering Intent = "Presentation Optional" with a CAD Operating Point <= n are displayed**