

Digital Imaging and Communications in Medicine (DICOM)

Supplement 130 -

Ophthalmic Refractive Measurements Storage and SR SOP Classes

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Scope and Field of Application

5 This Supplement to the DICOM Standard introduces a set of Measurement IODs for ophthalmic refractive instruments, and a Structured Report (SR) template for spectacle prescriptions. This is part of an ongoing program by DICOM WG9 to create a comprehensive set of DICOM information objects for the full range of ophthalmic instruments.

10 The Ophthalmic Measurements IODs and SOP classes are intended to support lensometers, autorefractors, keratometers, and subjective refraction devices. Later supplements may provide IODs and SR templates for other ophthalmic exam measurements not produced by these types of devices, including for axial length measurement devices and manual measurements entered by humans via keyboard, touchscreen or similar data input methods.

15 Ophthalmic refractive devices currently do not have a specific data representation in the DICOM standard. These are not imaging modalities, but modalities that produce a set of numeric measurement values. IHE Eye Care Year 1 defined representation of the outputs of these types of devices using DICOM Encapsulated PDF. Although useful for a storage and viewing solution, it does not provide access to the discrete data produced by these instruments. These Ophthalmic Measurements IODs define the discrete data attributes measured by these types of devices.

20

25

Changes to NEMA Standards Publication PS 3.2-2007
Digital Imaging and Communications in Medicine (DICOM)
Part 2: Conformance

30 **Item: Add to table A.1-2 categorizing SOP Classes:**

The SOP Classes are categorized as follows:

**Table A.1-2
 UID VALUES**

UID Value	UID NAME	Category
...
<u>1.2.840.10008.5.1.4.1.1.78.1</u>	<u>Lensometry Measurements Storage</u>	<u>Transfer</u>
<u>1.2.840.10008.5.1.4.1.1.78.2</u>	<u>Autorefraction Measurements Storage</u>	<u>Transfer</u>
<u>1.2.840.10008.5.1.4.1.1.78.3</u>	<u>Keratometry Measurements Storage</u>	<u>Transfer</u>
<u>1.2.840.10008.5.1.4.1.1.78.4</u>	<u>Subjective Refraction Measurements Storage</u>	<u>Transfer</u>
<u>1.2.840.10008.5.1.4.1.1.78.5</u>	<u>Visual Acuity Measurements Storage</u>	<u>Transfer</u>
<u>1.2.840.10008.5.1.4.1.1.78.6</u>	<u>Spectacle Prescription Report Storage</u>	<u>Transfer</u>
...

35

40

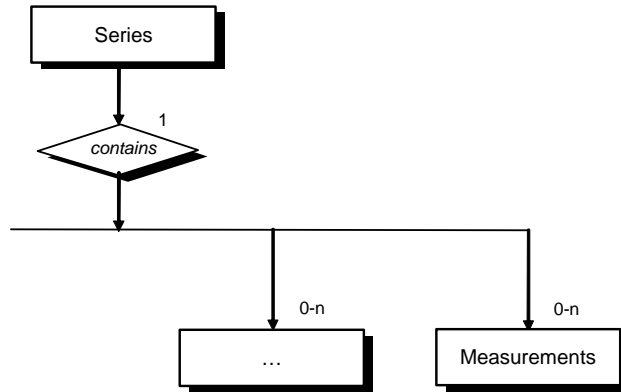
Changes to NEMA Standards Publication PS 3.3-2007

45

Digital Imaging and Communications in Medicine (DICOM)

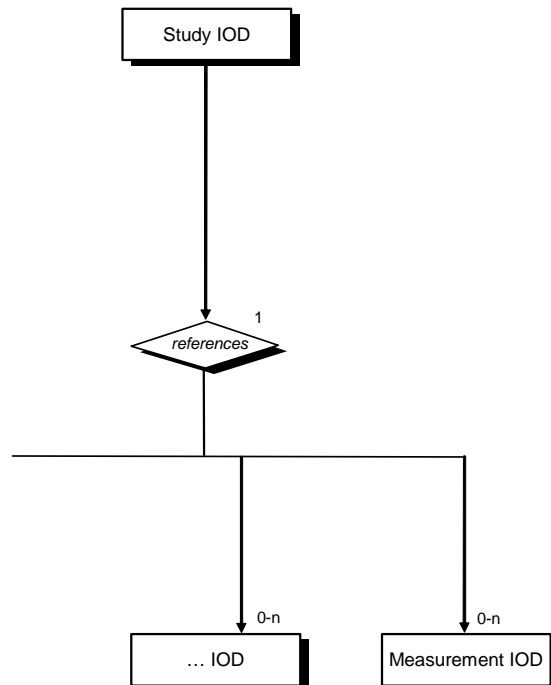
Part 3: Information Object Definitions

Modify Section 7 DICOM Model of the real world – Add Ophthalmic Measurements to Figure 7-1a



50

Figure 7-1a
DICOM MODEL OF THE REAL WORLD



55

Figure 7-2a
DICOM INFORMATION MODEL

Modify Section A.1.2 IOD E-R Model – Add Measurements to Figure A.1-1.

60

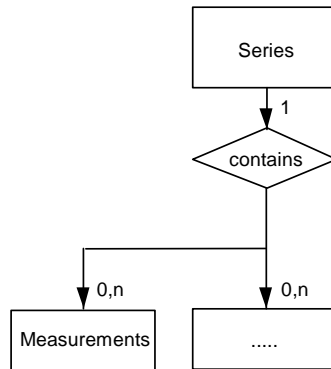


Figure A.1-1
DICOM COMPOSITE INSTANCE IOD INFORMATION MODEL

<u>General Ophthalmic Refractive Measurements</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	
<u>Lensometry Measurements</u>	<u>M</u>					
<u>Autorefraction Measurements</u>		<u>M</u>				
<u>Keratometry Measurements</u>			<u>M</u>			
<u>Subjective Refraction Measurements</u>				<u>M</u>		
<u>Visual Acuity Measurements</u>					<u>M</u>	
SR Document Series						<u>M</u>
SR Document General						<u>M</u>
SR Document Content						<u>M</u>
SOP Common	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>	<u>M</u>

75

Add the following to Ophthalmic Measurements IODs PS 3.3 Annex A

A.5A Ophthalmic Refractive Measurements Information Object Definitions

80 The following IODs specify module use for storage of the measurements from ophthalmic refractive instruments. These instruments address the power of a lens or of a patient's eye to bend light. There are many ophthalmic refractive instruments used to create this type of information. Some examples include Lensometers, Keratometers, Autorefractors, etc. An Ophthalmic Measurements SOP Instance is related to a single Series within a single Study.

A.5A.1 Lensometry Measurements Information Object Definition

A.5A.1.1 Lensometry Measurements Information Object Description

85 The Lensometry Measurements IOD is used to capture the refractive measurements by a lensometer of spectacles.

A.5A.1.2 Lensometry Measurements IOD Entity-Relationship Model

The E-R Model in Section A.1.2 of this Part applies to the Lensometry Measurements IOD.

A.5A.1.3 Lensometry Measurements IOD Module Table

90 Table A.5A.1-1 specifies the Modules of the Lensometry Measurements IOD.

**Table A.5A.1-1
LENSOMETRY MEASUREMENTS IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U

Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Lensometry Measurements Series	C.8.X.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.X.7	M
	Lensometry Measurements	C.8.X.8	M
	SOP Common	C.12.1	M

A.5A.2 Autorefracton Measurements Information Object Definition

95 **A.5A.2.1 Autorefracton Measurements Information Object Description**

The Autorefracton Measurements IOD is used to encode the results of a modality (autorefractor) that automatically determines, without patient input, what a patient's refractive correction should be.

A.5A.2.2 Autorefracton Measurements IOD Entity-Relationship Model

100 The E-R Model in Section A.1.2 of this Part applies to the Autorefracton Measurements IOD.

A.5A.2.3 Autorefracton Measurements IOD Module Table

Table A.5A.2-1 specifies the Modules of the Autorefracton Measurements IOD.

**Table A.5A.2-1
AUTOREFRACTON MEASUREMENTS IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Autorefracton Measurements Series	C.8.X.2	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M

Measurements	General Ophthalmic Refractive Measurements	C.8.X.7	M
	Autorefractive Measurements	C.8.X.9	M
	SOP Common	C.12.1	M

105

A.5A.3 Keratometry Measurements Information Object Definition

A.5A.3.1 Keratometry Measurements Information Object Description

The Keratometry Measurements IOD is used to encode the measurements of a modality (keratometer) that measures the curvature, and thus the refractive power, of a patient's cornea.

110 **A.5A.3.2 Keratometry Measurements IOD Entity-Relationship Model**

The E-R Model in Section A.1.2 of this Part applies to the Keratometry Measurements IOD.

A.5A.3.3 Keratometry Measurements IOD Module Table

Table A.5A.3-1 specifies the Modules of the Keratometry Measurements IOD.

115

**Table A.5A.3-1
KERATOMETRY MEASUREMENTS IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Keratometry Measurements Series	C.8.X.3	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.X.7	M
	Keratometry Measurements	C.8.X.10	M
	SOP Common	C.12.1	M

A.5A.4 Subjective Refraction Measurements Information Object Definition

A.5A.4.1 Subjective Refraction Measurements Information Object Description

120 The Subjective Refraction Measurements IOD is used for encoding the measurements that subjectively determine the refractive correction of the eye that results in best corrected visual acuity.

A.5A.4.2 Subjective Refraction Measurements IOD Entity-Relationship Model

The E-R Model in Section A.1.2 of this Part applies to the Subjective Refraction Measurements IOD.

125 **A.5A.4.3 Subjective Refraction Measurements IOD Module Table**

Table A.5A.4-1 specifies the Modules of the Subjective Refraction Measurements IOD.

**Table A.5A.4-1
SUBJECTIVE REFRACTION MEASUREMENTS IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Subjective Refraction Measurements Series	C.8.X.4	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.X.7	M
	Subjective Refraction Measurements	C.8.X.11	M
	SOP Common	C.12.1	M

130 **A.5A.5 Visual Acuity Measurements Information Object Definition**

A.5A.5.1 Visual Acuity Measurements Information Object Description

The Visual Acuity Measurements IOD is used to capture a patient's visual acuity relative to that of a reference standard patient under given viewing conditions (distance, lighting, etc.).

A.5A.5.2 Visual Acuity Measurements IOD Entity-Relationship Model

135 The E-R Model in Section A.1.2 of this Part applies to the Visual Acuity Measurements IOD.

A.5A.5.3 Visual Acuity Measurements IOD Module Table

Table A.5A.5-1 specifies the Modules of the Visual Acuity Measurements IOD.

**Table A.5A.5-1
VISUAL ACUITY MEASUREMENTS IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Visual Acuity Measurements Series	C.8.X.5	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.X.7	M
	Visual Acuity Measurements	C.8.X.12	M
	SOP Common	C.12.1	M

140

A.35.X Spectacle Prescription Report Information Object Definition

A.35.X.1 Spectacle Prescription Report Information Object Description

The Spectacle Prescription Report IOD is used to represent the spectacle prescription for a patient.

145 **A.35.X.2 Spectacle Prescription Report IOD Entity-Relationship Model**

The E-R Model in Section A.1.2 of this Part applies to the Spectacle Prescription Report IOD.

A.35.X.3 Spectacle Prescription Report IOD Module Table

Table A.35.X-1 specifies the Modules of the Spectacle Prescription Report IOD.

Table A.35.X-1

SPECTACLE PRESCRIPTION REPORT IOD MODULES

150

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.X.3.1 Spectacle Prescription Report IOD Content Constraints

A.35.X.3.1.1 Value Type

155 Value Type (0040,A040) in the Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

- TEXT
- CODE
- NUM
- 160 CONTAINER

A.35.X.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

165 Note: Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.X-2 specifies the relationship constraints of this IOD.

170 **Table A.35.X-2
RELATIONSHIP CONTENT CONSTRAINTS FOR SPECTACLE PRESCRIPTION REPORT IOD**

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	CONTAINER, CODE, NUM, TEXT

A.35.X.3.1.3 Template Constraints

The document shall be constructed from TID 2020 Spectacle Prescription Report invoked at the root node.

175

Update PS3.3 to add Modality values for the refractive measurements objects and retired OPR Ophthalmic Refraction

C.7.3.1.1.1 Modality

180 Defined Terms for the Modality (0008,0060) are:

- | | |
|--|---|
| <p>... ..</p> <p><u>AR</u> = Autorefraction</p> <p><u>VA</u> = Visual Acuity</p> <p><u>LEN</u> = Lensometry</p> | <p>... ..</p> <p><u>KER</u> = Keratometry</p> <p><u>SRF</u> = Subjective Refraction</p> <p><u>OPR</u> = Ophthalmic Refraction</p> |
|--|---|

Retired Defined Terms for the Modality (0008,0060) are:

- | | |
|--|-----------------------------|
| <p>..... ..</p> <p><u>OPR</u> = Ophthalmic Refraction (retired)</p> | <p>.. ..</p> <p>.... ..</p> |
|--|-----------------------------|

Update PS3.3 Annex A to include all the Ophthalmic Measurements Modules

185 **C.8.X Ophthalmic Refractive Measurements Modules**

C.8.X.1 Lensometry Measurements Series Module

The Lensometry Measurements IODs use the General Series module described in section C.7.3.1, specialized by the Lensometry Measurements Series Module, to describe the DICOM Series Entity described in A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

190

Table C.8.X.1-1 specifies the Attributes that identify and describe general information about the Lensometry Measurements Series.

**Table C.8.X.1-1
LENSOMETRY MEASUREMENTS SERIES MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: LEN See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). The Sequence shall have one Item. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
<i>>Include 'SOP Instance Reference Macro' Table 10-11</i>			

195

C.8.X.2 Autorefraction Measurements Series Module

The Autorefraction Measurements IODs use the General Series module described in section C.7.3.1, specialized by the Autorefraction Measurements Series Module, to describe the DICOM Series Entity described in A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

200

Table C.8.X.2-1 specifies the Attributes that identify and describe general information about the Autorefraction Measurements Series.

**Table C.8.X.2-1
AUTOREFRACTION MEASUREMENTS SERIES MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series.

			Enumerated Values: AR See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). The Sequence shall have one Item. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
>Include 'SOP Instance Reference Macro' Table 10-11			

205

C.8.X.3 Keratometry Measurements Series Module

The Keratometry Measurements IODs use the General Series module described in section C.7.3.1, specialized by the Keratometry Measurements Series Module, to describe the DICOM Series Entity described in A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

210

Table C.8.X.3-1 specifies the Attributes that identify and describe general information about the Keratometry Measurements Series.

**Table C.8.X.3-1
KERATOMETRY MEASUREMENTS SERIES MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: KER See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). The Sequence shall have one Item. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
>Include 'SOP Instance Reference Macro' Table 10-11			

215

C.8.X.4 Subjective Refraction Measurements Series Module

The Subjective Refraction Measurements IODs use the General Series module described in section C.7.3.1, specialized by the Subjective Refraction Measurements Series Module, to describe the DICOM Series Entity described in A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

220

Table C.8.X.4-1 specifies the Attributes that identify and describe general information about the Subjective Refraction Measurements Series.

**Table C.8.X.4-1
SUBJECTIVE REFRACTION MEASUREMENTS SERIES MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: SRF See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). The Sequence shall have one Item. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
>Include 'SOP Instance Reference Macro' Table 10-11			

225

C.8.X.5 Visual Acuity Measurements Series Module

The Visual Acuity Measurements IODs use the General Series module described in section C.7.3.1, specialized by the Visual Acuity Measurements Series Module, to describe the DICOM Series Entity described in A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

230

Table C.8.X.5-1 specifies the Attributes that identify and describe general information about the Visual Acuity Measurements Series.

**Table C.8.X.5-1
VISUAL ACUITY MEASUREMENTS SERIES MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: VA

			See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). The Sequence shall have one Item. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
>Include 'SOP Instance Reference Macro' Table 10-11			

235

C.8.X.6 General Ophthalmic Refractive Macros

C.8.X.6.1 Cylinder Sequence Macro

Table C.8.X.6.1-1 describes the attributes for the Cylinder Sequence Macro

**Table C.8.X.6.1-1
CYLINDER SEQUENCE MACRO**

240

Attribute Name	Tag	Type	Attribute Description
Cylinder Sequence	(0046,0018)	1C	A sequence that specifies lens measurements to correct for astigmatism or measurements of an eye that has astigmatism. Required if astigmatic correction or astigmatism is measured. Only a single item shall be permitted. Note: When astigmatism is present the power is NOT the same in all meridians, but has its minimum and maximum power in meridians separated by 90 degrees.
>Cylinder Power	(0046,0147)	1	The power that is present at the power meridian (90 degrees from the axis), in diopters.
>Cylinder Axis	(0022,0009)	1	The meridian, defined in degrees, that is 90 degrees from the power meridian.

C.8.X.6.2 Prism Sequence Macro

Table C.8.X.6.2-1 describes the attributes for the Prism Sequence Macro

**Table C.8.X.6.2-1
PRISM SEQUENCE MACRO**

245

Attribute Name	Tag	Type	Attribute Description
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Prism Sequence	(0046,0028)	1C	A sequence that specifies prism that is measured in a lens, or that is required to correct for a patient's ocular misalignment. Required if prism is measured in the lens or if this part of a refraction is done for a patient. Only a single item shall be permitted. Note: A prism is a wedge shaped lens that deviates light toward the base and shifts the apparent image toward its apex.
>Horizontal Prism Power	(0046,0030)	1	The power of a prism to bend light in the horizontal direction, in prism diopters.
>Horizontal Prism Base	(0046,0032)	1	Direction of the base of the measured prism -- either in (toward the nose), or out (away from the nose) Enumerated Value: IN OUT
>Vertical Prism Power	(0046,0034)	1	The power of a prism to bend light in the vertical direction, in prism diopters.
>Vertical Prism Base	(0046,0036)	1	Direction of the base of the measured prism -- either up, or down. Enumerated Value: UP DOWN

C.8.X.7 General Ophthalmic Refractive Measurements Module

Table C.8.X.7-1 defines the General Ophthalmic Refractive Measurements module attributes.

250

**Table C.8.X.7-1
GENERAL OPHTHALMIC REFRACTIVE MEASUREMENTS MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies these measurements.
Content Date	(0008,0023)	1	The date the measurements data creation started.
Content Time	(0008,0033)	1	The time the measurements data creation started.
Referenced Refractive Measurements Sequence	(0046,0145)	2C	A sequence that specifies Ophthalmic Refractive Measurements SOP Instances that are relevant to the interpretation of this SOP Instance. Zero or more items may be included in this sequence. See section C.8.X.7.1.1 for further

		explanation. Required if Visual Acuity Type Code Sequence (0046,0121) is present. May be present otherwise.
>Include 'SOP Instance Reference Macro' Table 10-11		

C.8.X.7.1 General Ophthalmic Refractive Measurements Module Attributes

C.8.X.7.1.1 Referenced Refractive Measurements Sequence

255 Whenever visual acuity is measured it is necessary to know the conditions under which it was measured. If the vision was measured with the patient's habitual correction in place, this attribute is used to reference a lensometry measurements SOP instance for the current glasses. If the measurements are of the patient's best-corrected vision, this attribute may reference the SOP instance that describes the correction that resulted in that vision, which may for example be the
260 subjective refraction, or the autorefractor.

This attribute enables a receiver of this SOP instance to identify the results of measurements from a lensometer, autorefractor, or automated phoropter (subjective refraction) that are relevant to interpretation.

C.8.X.8 Lensometry Measurements Module

265 Table C.8.X.8-1 defines the Attributes used to capture the refractive measurements by a lensometer for spectacles. This is typically for a pair of lenses, but sometimes for just one. Sometimes a single lens is measured with an unknown laterality.

**Table C.8.X.8-1
LENSOMETRY MEASUREMENTS MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Lens Description	(0046,0012)	2	A free text description of the lens and lens general comments. Note: A common example is to identify the specific spectacles measured
Right Lens Sequence	(0046,0014)	1C	A sequence that specifies measurements of a patient's right lens. Required if the right lens is measured. Only a single item shall be present.
>Include 'Lensometry Measurements Macro' Table C.8.X.8-2			
Left Lens Sequence	(0046,0015)	1C	A sequence that specifies measurements of a patient's left lens. Required if the left lens is measured. Only a single item shall be present.
>Include 'Lensometry Measurements Macro' Table C.8.X.8-2			
Unspecified Laterality Lens Sequence	(0046,0016)	1C	A sequence that specifies measurements of one lens of unknown laterality. Shall not be included if Attribute Right Lens Sequence (0046,0014) or Left Lens Sequence (0046,0015) is present. Required if a single lens of unknown laterality is measured. Only a single item

			shall be present.
<i>>Include 'Lensometry Measurements Macro' Table C.8.X.8-2</i>			

270

Table C.8.X.8-2 describes the attributes for the Lensometry Measurements Macro.

**Table C.8.X.8-2
LENSOMETRY MEASUREMENTS MACRO**

Attribute Name	Tag	Type	Attribute Description
Sphere Power	(0046,0146)	1	Refractive power of the lens that is the same in all meridians, measured at distance (optical infinity), in diopters.
<i>Include 'Cylinder Sequence Macro' Table C.8.X.6.1-1</i>			
Add Near Sequence	(0046,0100)	1C	A sequence that specifies refractive measurements of the lens to correct for inability to focus at near while wearing the distance prescription. Required if Add Near is measured in the lens. Only one item shall be permitted.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this sequence.
Add Intermediate Sequence	(0046,0101)	1C	A sequence that specifies refractive measurements of the lens to correct for inability to focus at intermediate distance while wearing the distance prescription. Required if Add intermediate is measured in the lens. Only one item shall be permitted.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this sequence item.
<i>Include 'Prism Sequence Macro' Table C.8.X.6.2-1</i>			
Lens Segment Type	(0046,0038)	3	The type of segment of a lens containing the "add" power, as described above Enumerated Value: PROGRESSIVE NONPROGRESSIVE

Optical Transmittance	(0046,0040)	3	The fraction of light that passes through the measured lens optical media, in percent.
Channel Width	(0046,0042)	3	In a progressive lens, the width in mm of that portion of the lens where there is gradual or progressive increase in "add" power. Note: See Attributes, Add Near Sequence (0046,0100) and Add Intermediate Sequence (0046,0101) for description of "add".

275 **C.8.X.9 Autorefracton Measurements Module**

Table C.8.X.9-1 defines the Attributes used to represent the refractive measurements by an autorefractor of a patient's eyes. Usually both eyes are measured, but sometimes just one.

**Table C.8.X.9-1
AUTOREFRACTION MEASUREMENTS MODULE ATTRIBUTES**

280

Attribute Name	Tag	Type	Attribute Description
Autorefracton Right Eye Sequence	(0046,0050)	1C	A sequence that specifies refractive measurements of a patient's right eye. Required if the right eye is measured. Only one item shall be permitted.
>Sphere Power	(0046,0146)	1	Refractive power of the eye that is the same in all meridians, measured at distance (optical infinity), in diopters.
<i>>Include 'Cylinder Sequence Macro' Table C.8.X.6.1-1</i>			
>Pupil Size	(0046,0044)	3	The horizontal diameter measurement of the pupil, in mm.
>Corneal Size	(0046,0046)	3	The horizontal diameter measurement of the cornea, in mm.
Autorefracton Left Eye Sequence	(0046,0052)	1C	A sequence that specifies refractive measurements of a patient's left eye. Required if the left eye is measured. Only one item shall be permitted.
>Sphere Power	(0046,0146)	1	Refractive power of the eye that is the same in all meridians, measured at distance (optical infinity), in diopters.
<i>>Include 'Cylinder Sequence Macro' Table C.8.X.6.1-1</i>			
>Pupil Size	(0046,0044)	3	The horizontal diameter measurement of the pupil, in mm.
>Corneal Size	(0046,0046)	3	The horizontal diameter measurement of the cornea, in mm.
Distance Pupillary Distance	(0046,0060)	3	Distance in mm between the pupils when the patient's object of regard is in the distance, as measured by an autorefractor.

Near Pupillary Distance	(0046,0062)	3	Distance in mm between the pupils when the patient's object of regard is at near, as measured by an autorefractor.
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C.8.X.10 Keratometry Measurements Module

Table C.8.X.10-1 defines the Attributes used to represent the keratometric measurements by a keratometer of a patient's eyes. Usually both eyes are measured, but sometimes just one.

285

**Table C.8.X.10-1
KERATOMETRY MEASUREMENTS MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Keratometry Right Eye Sequence	(0046,0070)	1C	A sequence that specifies keratometric measurements of a patient's right eye, defining principal meridians wherein the steepest meridian is separated by 90 degrees from the flattest. Required if the right eye is measured. Only one item shall be permitted. Note: Consideration for steep, flat, and spherical meridians is made. For instances where spherical keratometric measurements are obtained, values specified in the steep and flat Attributes are equivalent.
<i>>Include 'Keratometric Measurements Macro' Table C.8.X.10-2</i>			
Keratometry Left Eye Sequence	(0046,0071)	1C	A sequence that specifies keratometric measurements of a patient's left eye, defining principal meridians wherein the steepest meridian is separated by 90 degrees from the flattest. Required if the left eye is measured. Only one item shall be permitted. Note: See Note for attribute Keratometry Right Eye Sequence (0046,0070)
<i>>Include 'Keratometric Measurements Macro' Table C.8.X.10-2</i>			

Table C.8.X.10-2 describes the attributes for the Keratometric Measurements Macro.

**Table C.8.X.10-2
KERATOMETRIC MEASUREMENTS MACRO**

290

Attribute Name	Tag	Type	Attribute Description
Steep Keratometric Axis Sequence	(0046,0074)	1	A sequence that specifies the steepest meridian as defined by the greatest power of curvature and shortest radius of curvature. Only one item shall be permitted.

>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	1	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	1	The meridian where the keratometric radius of curvature or power is measured, in degrees.
Flat Keratometric Axis Sequence	(0046,0080)	1	A sequence that specifies the flattest meridian as defined by the least power of curvature and longest radius of curvature. Only one item shall be permitted.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	1	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	1	The meridian where the keratometric radius of curvature or power is measured, in degrees.

C.8.X.11 Subjective Refractive Measurements Module

Table C.8.X.11-1 defines the Attributes used to represent the subjective refractive measurements of a patient's eyes. Usually both eyes are measured, but sometimes just one.

295

**Table C.8.X.11-1
SUBJECTIVE REFRACTIVE MEASUREMENTS MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Subjective Refraction Right Eye Sequence	(0046,0097)	1C	A sequence that specifies the subjective refractive measurements of a patient's right eye. Required if the right eye is measured. Only one item shall be permitted.
<i>>Include 'Subjective Refractive Measurements Macro' Table C.X.8.11-2</i>			
Subjective Refraction Left Eye Sequence	(0046,0098)	1C	A sequence that specifies the subjective refractive measurements of a patient's left eye. Required if the left eye is measured. Only one item shall be permitted.
<i>>Include 'Subjective Refractive Measurements Macro' Table C.X.8.11-2</i>			
Distance Pupillary Distance	(0046,0060)	3	Distance in mm between the pupils when the patient's object of regard is in the distance, as measured by a phoropter.
Near Pupillary Distance	(0046,0062)	3	Distance in mm between the pupils when the patient's object of regard is at near, as measured by a phoropter.

Intermediate Pupillary Distance	(0046,0063)	3	Distance in mm between the pupils when the patient's object of regard is at an intermediate distance, as measured by a phoropter.
Other Pupillary Distance	(0046,0064)	3	Distance in mm between the pupils when the patient's object of regard is at the distance specified in the attribute Add Other Sequence (0046,0102), as measured by a phoropter.

Table C.8.X.11-2 describes the attributes used for the Subjective Refractive Measurements Macro

300

**Table C.8.X.11-2
SUBJECTIVE REFRACTIVE MEASUREMENTS MACRO**

Attribute Name	Tag	Type	Attribute Description
Sphere Power	(0046,0146)	1	Refractive power of the eye that is the same in all meridians, measured at distance (optical infinity), in diopters.
<i>Include 'Cylinder Sequence Macro' Table C.8.X.6.1-1</i>			
<i>Include 'Prism Sequence Macro' Table C.8.X.6.2-1</i>			
Add Near Sequence	(0046,0100)	1C	A sequence that specifies refractive measurements of the eye to correct for inability to focus at near while wearing the distance prescription. Required if near point refraction is done. Only one item shall be permitted.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this sequence.
Add Intermediate Sequence	(0046,0101)	1C	A sequence that specifies refractive measurements of the eye to correct for inability to focus at intermediate distance while wearing the distance prescription. Required if intermediate point refraction is done. Only one item shall be permitted.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity using the value of Add Power (0046,0104) in this sequence item.

Add Other Sequence	(0046,0102)	1C	A sequence that specifies refractive measurements of the eye to correct for inability to focus at the below specified distance while wearing the distance prescription. Required if refraction is done at less than distance (optical infinity), but at a distance other than "near" or "intermediate" Only one item shall be permitted.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this sequence item.

C.8.X.12 Visual Acuity Measurements Module

305 Table C.8.X.12-1 defines the Attributes used to represent the subjective measurements of a patient's visual acuity. Usually each eye is measured individually, but sometimes only one eye is measured; sometimes the visual acuity of both eyes working together is measured. The visual acuity may be measured uncorrected, or with various refractive corrections, such as best corrected distance, pinhole, habitual near, etc

**Table C.8.X.12-1
VISUAL ACUITY MEASUREMENTS MODULE ATTRIBUTES**

310

Attribute Name	Tag	Type	Attribute Description
Viewing Distance Type	(0046,0125)	1	The viewing distance conditions under which a patient's vision was measured. Enumerated Values: DISTANCE NEAR INTERMEDIATE OTHER
Visual Acuity Type Code Sequence	(0046,0121)	1	A sequence that specifies the conditions under which a patient's vision was measured. Only one item shall be permitted.
<i>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4216</i>			
Background Color	(0046,0092)	1	The color of the background upon which optotypes are displayed for measurements of visual acuity. Defined Terms: RED GREEN WHITE

Optotype	(0046,0094)	1	The standardized test type (standard object of regard) used in measurements of visual acuity. Defined Terms: LETTERS NUMBERS PICTURES TUMBLING E LANDOLT C
Optotype Detailed Definition	(0046,0139)	1C	Required if the Optotype (0046,0094) Attribute value is LETTERS or NUMBERS or PICTURES. Provides additional information to define what optotype was used. Note: Letters, numbers, and pictures are commonly used but poorly standardized. The tumbling E and Landolt C are well defined.
Optotype Presentation	(0046,0095)	1	Specifies whether single or multiple optotypes were presented. Enumerated Values: SINGLE MULTIPLE
Visual Acuity Right Eye Sequence	(0046,0122)	1C	A sequence that specifies the subjective measurement of a patient's visual acuity for the right eye. Required if the right eye is measured. Only one item shall be permitted.
<i>>Include 'Visual Acuity Measurements Macro' Table C.8.X.12-2</i>			
Visual Acuity Left Eye Sequence	(00gg,0123)	1C	A sequence that specifies the subjective measurements of a patient's visual acuity for the left eye. Required if the left eye is measured. Only one item shall be permitted.
<i>>Include 'Visual Acuity Measurements Macro' Table C.8.X.12-2</i>			
Visual Acuity Both Eyes Open Sequence	(0046,0124)	3	A sequence that specifies a patient's subjective visual acuity measurements with both eyes open. Only one item shall be permitted.
<i>>Include 'Visual Acuity Measurements Macro' Table C.8.X.12-2</i>			

Table C.8.X.12-2 describes the attributes for the Visual Acuity Measurements Macro.

**Table C.8.X.12-2
VISUAL ACUITY MEASUREMENTS MACRO**

Attribute Name	Tag	Type	Attribute Description
Decimal Visual Acuity	(0046,0137)	1	A patient's visual acuity specified in decimal. The value is derived from two values in a fraction where the numerator

			<p>of the fraction is the nominal distance to the chart that the patient is reading. The denominator represents the line of smallest optotypes of which the patient can see more than half.</p> <p>Notes: 1. Typical examples--reference standard is 1, severe vision loss is 0.1</p> <p>2. See PS 3.17 Ophthalmic Refractive Reports Use Cases for guidance in converting Decimal Visual Acuity to other customarily used display notation such as 20/20 in the US and 6/6 in Britain.</p>
Visual Acuity Modifiers	(0046,0135)	3	<p>The first value is a positive or negative integer numeric value such as +1, +2, +3, 0, -1, -2, or -3 used to indicate that the patient missed letters on the line referenced, or saw additional letters on the next smaller line.</p> <p>The second value is a positive or negative integer numeric value such as +1, +2, +3, 0, -1, -2, or -3 which in combination with the first value indicates that the patient both saw additional letters on the next smaller line and missed letters on the line referenced.</p> <p>Notes: 1. When the modifier values are zero, the values are not typically displayed to the user.</p> <p>2. See Annex X for guidance regarding significance of modifiers.</p>

320

325

Changes to NEMA Standards Publication PS 3.4-2007
Digital Imaging and Communications in Medicine (DICOM)
Part 4: Service Class Specifications

Add Ophthalmic Measurements SOP Classes to PS3.4 Annex B

330 **B.3.1.4 Related General SOP Classes (A-ASSOCIATE-RQ)**

SOP Class Name	Related General SOP Class Name
<u>Spectacle Prescription Report</u>	<u>Enhanced SR</u>

B.5 Standard SOP Classes

335 **Table B.5-1
STANDARD SOP CLASSES**

SOP Class Name	SOP Class UID	IOD (See PS 3.3)
<u>Lensometry Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.1</u>	<u>Lensometry Measurements</u>
<u>Autorefractometry Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.2</u>	<u>Autorefractometry Measurements</u>
<u>Keratometry Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.3</u>	<u>Keratometry Measurements</u>
<u>Subjective Refraction Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.4</u>	<u>Subjective Refraction Measurements</u>
<u>Visual Acuity Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.5</u>	<u>Visual Acuity Measurements</u>
<u>Spectacle Prescription Report Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.6</u>	<u>Spectacle Prescription Report</u>

B.5.1.5 Structured Reporting Storage SOP Classes

The requirements of Annex O apply to the following SOP Classes:

- 340
- Basic Text SR
 - Enhanced SR, and SOP Classes for which it is the Related General SOP Class
- 345
- Comprehensive SR, and SOP Classes for which it is the Related General SOP Class
 - Mammography CAD SR
- 350
- Chest CAD SR
 - Procedure Log
 - X-Ray Radiation Dose SR
- 355
- Spectacle Prescription Report

Add Ophthalmic Measurements Media Storage SOP Class to PS3.4 Annex I

I.4 MEDIA STANDARD STORAGE SOP Classes

**Table I.4-1
Media Storage Standard SOP Classes**

SOP Class Name	SOP Class UID	IOD (See PS 3.3)
<u>Lensometry Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.1</u>	<u>Lensometry Measurements</u>
<u>Autorefracton Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.2</u>	<u>Autorefracton Measurements</u>
<u>Keratometry Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.3</u>	<u>Keratometry Measurements</u>
<u>Subjective Refraction Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.4</u>	<u>Subjective Refraction Measurements</u>
<u>Visual Acuity Storage Measurements Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.5</u>	<u>Visual Acuity Measurements</u>
<u>Spectacle Prescription Report Storage</u>	<u>1.2.840.10008.5.1.4.1.1.78.6</u>	<u>Spectacle Prescription Report</u>

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I.4.1.2 Structured Reporting Storage SOP Classes

The requirements of Annex O apply to the following SOP Classes:

365

- Basic Text SR
- Enhanced SR, and SOP Classes for which it is the Related General SOP Class
- Comprehensive SR, and SOP Classes for which it is the Related General SOP Class

370

- Mammography CAD SR
- Chest CAD SR

375

- Procedure Log
- X-Ray Radiation Dose SR

380

- **Spectacle Prescription Report**

Add Annex X for Ophthalmic Measurements Storage SOP Classes

405

410

Changes to NEMA Standards Publication PS 3.6-2007
Digital Imaging and Communications in Medicine (DICOM)
Part 6: Data Dictionary

415

Modify PS3.6 Section 6 Registry of DICOM data elements – add new items.

Tag	Name	VR	VM
(0046,0012)	Lens Description	LO	1
(0046,0014)	Right Lens Sequence	SQ	1
(0046,0015)	Left Lens Sequence	SQ	1
(0046,0016)	Unspecified Laterality Lens Sequence	SQ	1
(0046,0018)	Cylinder Sequence	SQ	1
(0046,0028)	Prism Sequence	SQ	1
(0046,0030)	Horizontal Prism Power	FD	1
(0046,0032)	Horizontal Prism Base	CS	1
(0046,0034)	Vertical Prism Power	FD	1
(0046,0036)	Vertical Prism Base	CS	1
(0046,0038)	Lens Segment Type	CS	1
(0046,0040)	Optical Transmittance	FD	1
(0046,0042)	Channel Width	FD	1
(0046,0044)	Pupil Size	FD	1
(0046,0046)	Corneal Size	FD	1
(0046,0050)	Autorefracton Right Eye Sequence	SQ	1
(0046,0052)	Autorefracton Left Eye Sequence	SQ	1
(0046,0060)	Distance Pupillary Distance	FD	1
(0046,0062)	Near Pupillary Distance	FD	1
(0046,0063)	Intermediate Pupillary Distance	FD	1
(0046,0064)	Other Pupillary Distance	FD	1
(0046,0070)	Keratometry Right Eye Sequence	SQ	1
(0046,0071)	Keratometry Left Eye Sequence	SQ	1
(0046,0074)	Steep Keratometric Axis Sequence	SQ	1
(0046,0075)	Radius of Curvature	FD	1
(0046,0076)	Keratometric Power	FD	1
(0046,0077)	Keratometric Axis	FD	1
(0046,0080)	Flat Keratometric Axis Sequence	SQ	1
(0046,0092)	Background Color	CS	1
(0046,0094)	Optotype	CS	1

Tag	Name	VR	VM
(0046,0095)	Optotype Presentation	CS	1
(0046,0097)	Subjective Refraction Right Eye Sequence	SQ	1
(0046,0098)	Subjective Refraction Left Eye Sequence	SQ	1
(0046,0100)	Add Near Sequence	SQ	1
(0046,0101)	Add Intermediate Sequence	SQ	1
(0046,0102)	Add Other Sequence	SQ	1
(0046,0104)	Add Power	FD	1
(0046,0106)	Viewing Distance	FD	1
(0046,0121)	Visual Acuity Type Code Sequence	SQ	1
(0046,0122)	Visual Acuity Right Eye Sequence	SQ	1
(0046,0123)	Visual Acuity Left Eye Sequence	SQ	1
(0046,0124)	Visual Acuity Both Eyes Open Sequence	SQ	1
(0046,0125)	Viewing Distance Type	CS	1
(0046,0135)	Visual Acuity Modifiers	SS	2
(0046,0137)	Decimal Visual Acuity	FD	1
(0046,0139)	Optotype Detailed Definition	LO	1
(0046,0145)	Referenced Refractive Measurements Sequence	SQ	1
(0046,0146)	Sphere Power	FD	1
(0046,0147)	Cylinder Power	FD	1

420

Add the Ophthalmic Measurements UIDs to PS3.6 Annex A:

Annex A (Normative): Registry of DICOM Unique Identifiers (UID)

UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.5.1.4.1.1.78.1	Lensometry Measurements Storage	SOP Class	3.4
1.2.840.10008.5.1.4.1.1.78.2	Autorefractometry Measurements Storage	SOP Class	3.4
1.2.840.10008.5.1.4.1.1.78.3	Keratometry Measurements Storage	SOP Class	3.4

1.2.840.10008.5.1.4.1.1.78.4	Subjective Refraction Measurements Storage	SOP Class	3.4
1.2.840.10008.5.1.4.1.1.78.5	Visual Acuity Measurements	SOP Class	3.4
1.2.840.10008.5.1.4.1.1.78.6	Spectacle Prescription Reports Storage	SOP Class	3.4

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430

Changes to NEMA Standards Publication PS 3.16-2007

435

**Digital Imaging and Communications in Medicine (DICOM)
Part 16: Content Mapping Resource**

Item: Add to PS3.16:

TID 2020 Template for Spectacle Prescription Report Root Template

440 The Spectacle Prescription Report is a structured report used to represent the prescription for a patient. Usually a prescription is for both eyes, but sometimes just one. The Spectacle Prescription Report defines a refractive correction relative to which visual acuity may be measured subjectively, and thus may be referenced by a Visual Acuity Measurements Storage SOP Instance.

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**TID 2020
Spectacle Prescription Report
Type: Extensible**

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (111671, 99SUP130, "Spectacle Prescription Report")	1	M		
2	>	CONTAINS	CONTAINER	EV (111688, 99SUP130, "Right Eye Rx")	1	UC	IF Right Spectacle Lens is prescribed	
3	>>	CONTAINS	INCLUDE	TID (2021) Spectacle Prescription Details	1	M		
4	>	CONTAINS	CONTAINER	EV (111689, 99SUP130, "Left Eye Rx")	1	UC	IF Left Spectacle Lens is prescribed	
5	>>	CONTAINS	INCLUDE	TID (2021) Spectacle Prescription Details	1	M		
6	>	CONTAINS	NUM	EV (111679, 99SUP130, "Distance Pupillary Distance")	1	U		\$UNITS=EV(mm,UCUM,"mm")
7	>	CONTAINS	NUM	EV (111680, 99SUP130, "Near Pupillary Distance")	1	U		\$UNITS=EV(mm,UCUM,"mm")
8	>	CONTAINS	TEXT	EV (121106, DCM, "Comments")	1	U		

450

TID 2021 Template for Spectacle Prescription Details

**TID 2021
Spectacle Prescription Details
Type: Extensible**

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1		CONTAINS	NUM	EV (F-02FB4, SRT, "Sphere")	1	M		\$UNITS=EV([diop],UCUM,"diopters")
2		CONTAINS	NUM	EV (F-A2143, SRT, "Cylinder Power")	1	UC	IF Cylinder is prescribed	\$UNITS=EV([diop],UCUM,"diopters")
3		CONTAINS	NUM	EV (F-02FB7, SRT, "Axis")	1	MC	IF ROW 2 is Present	\$UNITS=EV(deg,UCUM ,"degrees")
4		CONTAINS	NUM	EV (111672, 99SUP130, "Add Near")	1	UC	IF Add Near is prescribed	\$UNITS=EV([diop],UCUM,"diopters")
5		CONTAINS	NUM	EV (111673, 99SUP130, "Add Intermediate")	1	UC	IF Add Intermediate is prescribed	\$UNITS=EV([diop],UCUM,"diopters")
6		CONTAINS	NUM	EV (111674, 99SUP130, "Add Other")	1	UC	IF Add Other is prescribed	\$UNITS=EV([diop],UCUM,"diopters")
7		CONTAINS	NUM	EV (111675, 99SUP130, "Horizontal Prism Power")	1	UC	IF Horizontal Prism is prescribed	\$UNITS=EV([p'diop],UCUM,"prism diopters")
8		CONTAINS	CODE	EV (111676, 99sup130, "Horizontal Prism Base")	1	MC	IF ROW 7 is present	DCID (4214) Ophthalmic Horizontal Directions
9		CONTAINS	NUM	EV (111677, 99SUP130, "Vertical Prism Power")	1	UC	IF Vertical Prism is prescribed	\$UNITS=EV([p'diop],UCUM,"prism diopters")
10		CONTAINS	CODE	EV (111678, 99SUP130, "Vertical Prism Base")	1	MC	IF Row 9 is present	DCID (4215) Ophthalmic Vertical Directions

Add the following to PS3.16 Annex B (as adopted in Supplement 53):

455

CID 29 Acquisition Modality

**Context ID 29
Acquisition Modality**

Type: Extensible

Version: 2006402380124

Coding Scheme Designator	Code Value	Code Meaning
.....
<u>DCM</u>	<u>AR</u>	<u>Autorefraction</u>
<u>DCM</u>	<u>KER</u>	<u>Keratometry</u>
<u>DCM</u>	<u>LEN</u>	<u>Lensometry</u>
<u>DCM</u>	<u>SRF</u>	<u>Subjective Refraction</u>
<u>DCM</u>	<u>VA</u>	<u>Visual Acuity</u>

460

CID 4214 Ophthalmic Horizontal Directions

Context ID 4214

Ophthalmic Horizontal Directions

Type: Extensible

Version: 20080124

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
SRT	G-C028	Inward
SRT	R-404C7	Outward

465

CID 4215 Ophthalmic Vertical Directions

Context ID 4215

Ophthalmic Vertical Directions

Type: Extensible

Version:20080124

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
SRT	R-404BE	Up
SRT	R-404B3	Down

470

CID 4216 Ophthalmic Visual Acuity Type

Context ID 4216

Ophthalmic Visual Acuity Type

Type: Extensible

Version: 20080124

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
99SUP130	111685	Autorefration Visual Acuity
99SUP130	111686	Habitual Visual Acuity
99SUP130	111687	Prescription Visual Acuity
SRT	F-04ECE	Potential Acuity Meter Visual Acuity
SRT	F-04D54	Best Corrected Visual Acuity
SRT	F-04D53	Uncorrected Visual Acuity
SRT	F-04D55	Pinhole Visual Acuity
SRT	F-04ECF	Brightness Acuity Testing Visual Acuity

475

Add to PS3.16 – Add To Annex D DICOM Controlled Terminology Definitions (Normative)

Code Value	Code Meaning	Definition	Notes
...			
111671	Spectacle Prescription Report	The spectacle prescription for a patient.	
111672	Add Near	Refractive measurements of the eye to correct for inability to focus at near while wearing the distance prescription.	
111673	Add Intermediate	Refractive measurements of the eye to correct for inability to focus at intermediate distance while wearing the distance prescription.	
111674	Add Other	Refractive measurements of the eye to correct for inability to focus at the specified distance while wearing the distance prescription.	
111675	Horizontal Prism Power	The power of a prism to bend light in the horizontal direction, in prism diopters	
111676	Horizontal Prism Base	Direction of the base of a horizontal prism -- either in (toward the nose), or out (away from the nose)	
111677	Vertical Prism Power	The power of a prism to bend light in the vertical direction, in prism diopters.	
111678	Vertical Prism Base	Direction of the base of a vertical prism -- either up, or down.	
111679	Distance Pupillary Distance	Distance in mm between the pupils when the patient's object of regard is in the distance.	

Code Value	Code Meaning	Definition	Notes
111680	Near Pupillary Distance	Distance in mm between the pupils when the patient's object of regard is at near.	
111685	Autorefracton Visual Acuity	A patient's vision with the correction measured by an autorefractor in place.	
111686	Habitual Visual Acuity	A patient's vision with whichever vision correction the patient customarily wears	
111687	Prescription Visual Acuity	A patient's vision with the final spectacle prescription in place.	
111688	Right Eye Rx	The spectacle prescription for the right eye	
111689	Left Eye Rx	The spectacle prescription for the left eye	
AR	Autorefracton	Autorefracton device	
KER	Keratometry	Keratometry device	
LEN	Lensometry	Lensometry device	
SRF	Subjective Refraction	Subjective Refraction device	
VA	Visual Acuity	Visual Acuity device	

480

485

Changes to NEMA Standards Publication PS 3.16-2007
Digital Imaging and Communications in Medicine (DICOM)
Part 17: Explanatory Information

490

Add to PS3.17 – Add Use Cases for Refractive Instruments

Annex X Ophthalmic Refractive Reports Use Cases (Informative)

495 **X.1 Introduction**

Refractive instruments are the most commonly used instruments in eye care. At present many of them have the capability for digital output, but their data is most often addressed by manual input into a paper or electronic record.

500 Refractive instruments address the power of a lens or of a patient's eye to bend light. In order for a patient to see well light must be focused on the retina in the back of the eye. If the natural optics of a patient's eye do not accomplish this, corrective lenses can bend incident light so that it will be focused on the retina after passing through the optics of the eye. The power of an optical system such as a spectacle lens or the eye is measured by its ability to bend light, and is measured in diopters (D). In practical clinical applications, this is measured to 3 decimal points, in increments of 0.125 D. The power of a lens is measured in at least two major meridians. A spherical lens power occurs when the power is the same in all meridians (0-180 degrees). A cylindrical lens power occurs when there is a difference in lens power across the various meridians. The shape of the anterior surface of the eye largely determines what type of correcting lens is needed. An eye that requires only spherical lens power is usually shaped spherically, more like a ball, while an eye that requires cylindrical lens power is ellipsoid and shaped more like a football.

515 Lenses can also bend light without changing its focal distance. This type of refraction simply displaces the position of the image laterally. The power of a prism to bend light is measured in prism diopters. In practical clinical applications this is measured to 1 decimal point, in increments of 0.5 prism diopters. Prism power is required in a pair of spectacles most commonly when both eyes are not properly aligned with the object of regard. Clinical prisms are considered to bend all light coming in from the lens either up, down, in toward the nose, or out away from the nose, in order to compensate for ocular misalignment.

520 Visual acuity is measured in various *scales*, all of which indicate a patient's vision as a fraction of what a reference standard patient would see at any given distance. For example, if a patient has 20/30 vision it means that he sees from a distance of 20 feet what a reference standard patient would see from a distance of 30 feet. These measurements are determined by presentation of standardized objects or symbols (optotypes) of varying sizes calibrated to reference standard vision (20/20). The smallest discernable optotype defines the patient's visual acuity expressed in a variety of formats (letters, numbers, pictures, tumbling E, Landolt C, etc).

525 Visual acuity is measured in two categories of *viewing distances*: distance, and near. Distance visual acuity is measured at 20' or six meters. This distance is roughly equivalent to optical infinity for clinical purposes. The near viewing distance can vary from 30cm to 75 cm depending on a variety of other conditions, but most commonly is measured at 40 cm.

530 Visual acuity is measured under several common *viewing conditions*: 1) Uncorrected vision is measured using the autoprojector to project the above mentioned optotypes for viewing, with no lenses in front of the patient's eyes. The line of smallest optotypes of which the patient can see more than half is determined, and that information is uploaded to a computer system. 2) The patient's vision using habitual correction is measured in a similar fashion using whichever vision correction the patient customarily wears. 3) Pinhole vision is measured in a similar fashion, with the patient viewing the optotypes through a pinhole occluder held in front of the eye. Pinhole visual acuity testing reduces retinal blur, providing an approximation of what the patient's vision should be with the best possible refractive correction (spectacles) in place. 4) Best corrected visual acuity is the visual acuity with the best refractive correction in place. 5) Crowding visual

540 acuity measures the presence and amount of disparity in acuity between single optotype and multiple optotype presentations.

A patient's spectacle prescription may or may not represent the same lenses that provided best corrected visual acuity in his refraction. Subjective comfort plays a role in determining the final spectacle prescription.

545 1.) Autolensometer: an autolensometer is used to measure the refractive power of a patient's spectacles. This is done by the automatic analysis of the effect of the measured lens upon a beam of light passing through it. Output from an autolensometer can be uploaded to a phoropter to provide a baseline for subjective refraction (discussed below), and it can be uploaded to a computerized medical record. Lenses may also be measured to confirm manufacturing accuracy.

550 2.) Autorefractor: an autorefractor is used to automatically determine, without patient input, what refractive correction should provide best corrected visual acuity. Output from an autorefractor can be uploaded to a phoropter to provide a baseline for subjective refraction (discussed below), and it can be uploaded to a computerized medical record.

555 3.) Phoropter (or phoroptor): an instrument containing multiple lenses, that is used in the course of an eye exam to determine the individual's subjective response to various lenses (subjective refraction) and the need for glasses or contact lenses.. The patient looks through the phoropter lenses at an eye chart that may be at 20 ft or 6m or at a reading chart that may be at 40 cm. Information from the subjective refraction can be uploaded from an autophoropter to a computer. The best corrected vision that was obtained is displayed in an autopjector, and that information
560 can also be uploaded to a computer.

4.) Autokeratometer: an autokeratometer is used to measure the curvature, and thus the refractive power, of a patient's cornea. Two measurements are generally taken, one at the steepest and one at the flattest meridian of the cornea. The meridian measured is expressed in degrees, whole integers, in increments of 1 degree. If the measurement is expressed as power, the unit of measurement is diopters, to 3 decimal points, in increments of 0.125D. If the
565 measurement is expressed as radius of curvature, the unit of measurement is millimeters, to 2 decimal points, in increments of 0.01 mm.

X.2 REFERENCE TABLES for EQUIVALENT VISUAL ACUITY NOTATIONS

570 X.2.1 Background

Visual acuity is defined as the reciprocal of the ratio between the letter size that can just be recognized by a patient, relative to the size just recognized by a *standard eye*. If the patient requires letters that are twice as large (or twice as close), the visual acuity is said to be 1/2 ; if the letters need to be 5x larger, visual acuity is 1/5, and so on.

575 Note that the scales in the tables extend well above the reference standard (1.0, 20/20, the ability to recognize a letter subtending a visual angle 5 min. of arc), since normal acuity is often 1.25 (20/16), 1.6 (20/12.5) or even 2.0 (20/10).

580 Today, the ETDRS chart and ETDRS protocol, established by the National Eye Institute in the US, are considered to represent the de-facto gold standard for visual acuity measurements The International Council Of Ophthalmology, Visual Standard, Aspects and Ranges of Vision Loss (April, 2002) is a good reference document.

The full ETDRS protocol requires a wide chart, in the shape of an inverted triangle, on a light box, and cannot be implemented on the limited screen of a projector (or similar) chart.

585 For most routine clinical measurements projector charts or traditional charts with a rectangular shape are used; these non-standardized tools are less accurate than ETDRS measurements.

This appendix contains two lookup tables, one for traditional charts and one for ETDRS measurements.

X.2.2 Notations

590 Various notations may be used to express visual acuity. Snellen (in 1862) used a fractional notation in which the numerator indicated the actual viewing distance; this notation has long been abandoned for the use of equivalent notations, where the numerator is standardized to a fixed value, regardless of the true viewing distance. In Europe the use of decimal fractions is common (1/2 = 0.5, 1/5 = 0.2); in the US the numerator is standardized at 20 (1/2 = 20/40, 1/5 = 20/100),
695 while in Britain the numerator 6 is common (1/2 = 6/12, 1/5 = 6/30).

The linear scales on the right side of the tables are not meant for clinical records. They are required for statistical manipulations, such as calculation of differences, trends and averages and preferred for graphical presentations. They convert the logarithmic progression of visual acuity values to a linear one, based on Weber-Fechner's law, which states that proportional stimulus
600 increases lead to linear increases in perception.

The logMAR scale is calculated as $\log(\text{MAR}) = \log(1/V) = -\log(V)$. LogMAR notation is widely used in scientific publications. Note that it is a scale of vision loss, since higher values indicate poorer vision. The value "0" indicates "no loss", that is visual acuity equal to the reference standard (1.0, 20/20). Normal visual acuity (which is better than 1.0 (20/20)) is represented by
605 negative logMAR values.

The VAS scale (VAS = Visual Acuity Score) serves the same purpose. Its formula is: $100 - 50 \times \log\text{MAR}$ or $100 + 50 \times \log(V)$. It is more user friendly, since it avoids decimal values and is more intuitive, since higher values indicate better vision. The score is easily calculated on ETDRS charts, where 1 point is credited for each letter read correctly. The VAS scale also forms the basis
610 for the calculation of visual impairment ratings in the *AMA Guides to the Evaluation of Permanent Impairment*.

X.2.3 Use of the lookup table

Data input: Determine the notation used in the device and the values of the lines presented. No device will display all the values listed in each of the traditional columns. Convert these values to
615 the decimal DICOM storage values shown on the left of the same row. DICOM values are not meant for data display. In the table, they are listed in scientific notation to avoid confusion with display notations.

In the unlikely event that a value must be stored that does not appear in the lookup table, calculate the decimal equivalent and round to the nearest listed storage value.

620 Data display: If the display notation is the same as the input notation, convert the DICOM storage values back to the original values. If the notation chosen for the display is different from the input notation, choose the value on the same row from a different column. In certain cases this may result in an unfamiliar notation; unfortunately, this is unavoidable, given the differences in size progressions between different charts. If a suffix (see attribute "Visual Acuity Modifiers" (0046,0135)) is present, that suffix will be displayed as it was recorded.
625

Suffixes: Suffixes may be used to indicate steps that are smaller than a 1 line difference. On traditional charts, such suffixes have no defined numerical value. Suffixes +1, +2, +3 and -1, -2, -3 may be encountered. These suffixes do not correspond to a defined number of rows in the
630 table.

X.2.4 Traditional Charts

The Traditional charts used in clinical practice are not standardized; they have an irregular progression of letter sizes and a variable number of characters per line. Measurement accuracy

635 may further suffer from hidden errors that cannot be captured by any recording device, such as an inconsistent, non-standardized protocol, inaccurate viewing distance, inaccurate projector adjustment and contrast loss from room illumination. Therefore, the difference between two routine clinical measurements should not be considered significant, unless it exceeds 5 rows in the table (1 line on an ETDRS chart).

640 Table X-1 contains many blank lines to make the vertical scale consistent with that used in Table X-2. Notations within the same gray band are interchangeable for routine clinical use, since their differences are small compared to the clinical variability, which is typically in the order of 5 rows (1 ETDRS line).

645 **TABLE X-1**
Reference table for use with TRADITIONAL CHARTS

DICOM	Notations for Clinical Use with Traditional Charts	Scales for statistics and graphical displays																																																																																																																																																
Decimal Visual Acuity	Traditional scales	Linear Scales																																																																																																																																																
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">Decimal</th> <th style="width: 33%;">US</th> <th style="width: 33%;">6 m</th> </tr> </thead> <tbody> <tr><td>2.0</td><td>20/10</td><td>6/3</td></tr> <tr><td>1.91</td><td></td><td></td></tr> <tr><td>1.82</td><td></td><td></td></tr> <tr><td>1.74</td><td></td><td></td></tr> <tr><td>1.66</td><td></td><td></td></tr> <tr><td>1.60</td><td>1.6</td><td>20/12.5</td><td>6/3.8</td></tr> <tr><td>1.50</td><td>1.5</td><td>20/13</td><td>6/4</td></tr> <tr><td>1.45</td><td></td><td></td><td></td></tr> <tr><td>1.38</td><td></td><td></td><td></td></tr> <tr><td>1.30</td><td>1.3</td><td>20/15</td><td>6/4.5</td></tr> <tr><td>1.25</td><td>1.25</td><td>20/16</td><td>6/4.8</td></tr> <tr><td>1.20</td><td>1.2</td><td>20/17</td><td>6/5</td></tr> <tr><td>1.15</td><td></td><td></td><td></td></tr> <tr><td>1.10</td><td>1.1</td><td>20/18</td><td>6/5.5</td></tr> <tr><td>1.05</td><td></td><td></td><td></td></tr> <tr><td>1.00</td><td>1.0</td><td>20/20</td><td>6/6</td></tr> <tr><td>9.55 E-01</td><td></td><td></td><td></td></tr> <tr><td>9.00 E-01</td><td>0.9</td><td>20/22</td><td>6/6.6</td></tr> <tr><td>8.70 E-01</td><td></td><td></td><td></td></tr> <tr><td>8.30 E-01</td><td></td><td></td><td></td></tr> <tr><td>8.00 E-01</td><td>0.8</td><td>20/25</td><td>6/7.5</td></tr> <tr><td>7.50 E-01</td><td>0.75</td><td>20/26</td><td>6/8</td></tr> <tr><td>7.20 E-01</td><td></td><td></td><td></td></tr> <tr><td>7.00 E-01</td><td>0.7</td><td>20/28</td><td>6/8.7</td></tr> </tbody> </table>	Decimal	US	6 m	2.0	20/10	6/3	1.91			1.82			1.74			1.66			1.60	1.6	20/12.5	6/3.8	1.50	1.5	20/13	6/4	1.45				1.38				1.30	1.3	20/15	6/4.5	1.25	1.25	20/16	6/4.8	1.20	1.2	20/17	6/5	1.15				1.10	1.1	20/18	6/5.5	1.05				1.00	1.0	20/20	6/6	9.55 E-01				9.00 E-01	0.9	20/22	6/6.6	8.70 E-01				8.30 E-01				8.00 E-01	0.8	20/25	6/7.5	7.50 E-01	0.75	20/26	6/8	7.20 E-01				7.00 E-01	0.7	20/28	6/8.7	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">LogMAR</th> <th style="width: 50%;">VAS</th> </tr> </thead> <tbody> <tr><td>-0.30</td><td>115</td></tr> <tr><td>-0.28</td><td>114</td></tr> <tr><td>-0.26</td><td>113</td></tr> <tr><td>-0.24</td><td>112</td></tr> <tr><td>-0.22</td><td>111</td></tr> <tr><td>-0.20</td><td>110</td></tr> <tr><td>-0.18</td><td>109</td></tr> <tr><td>-0.16</td><td>108</td></tr> <tr><td>-0.14</td><td>107</td></tr> <tr><td>-0.12</td><td>106</td></tr> <tr><td>-0.10</td><td>105</td></tr> <tr><td>-0.08</td><td>104</td></tr> <tr><td>-0.06</td><td>103</td></tr> <tr><td>-0.04</td><td>102</td></tr> <tr><td>-0.02</td><td>101</td></tr> <tr><td>0</td><td>100</td></tr> <tr><td>0.02</td><td>99</td></tr> <tr><td>0.04</td><td>98</td></tr> <tr><td>0.06</td><td>97</td></tr> <tr><td>0.08</td><td>96</td></tr> <tr><td>0.10</td><td>95</td></tr> <tr><td>0.12</td><td>94</td></tr> <tr><td>0.14</td><td>93</td></tr> <tr><td>0.16</td><td>92</td></tr> </tbody> </table>	LogMAR	VAS	-0.30	115	-0.28	114	-0.26	113	-0.24	112	-0.22	111	-0.20	110	-0.18	109	-0.16	108	-0.14	107	-0.12	106	-0.10	105	-0.08	104	-0.06	103	-0.04	102	-0.02	101	0	100	0.02	99	0.04	98	0.06	97	0.08	96	0.10	95	0.12	94	0.14	93	0.16	92
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Page 51

6.60 E-01	0.66	20/30	6/9	0.18	91
6.30 E-01	0.63	20/32	6/9.5	0.20	90
6.00 E-01	0.6	20/33	6/10	0.22	89
5.75 E-01				0.24	88
5.50 E-01				0.26	87
5.25 E-01				0.28	86
5.00 E-01	0.5	20/40	6/12	0.30	85
4.80 E-01				0.32	84
4.57 E-01				0.34	83
4.37 E-01				0.36	82
4.17 E-01				0.38	81
4.00 E-01	0.4	20/50	6/15	0.40	80
3.80 E-01				0.42	79
3.60 E-01				0.44	78
3.50 E-01				0.46	77
3.33 E-01	0.33	20/60	6/18	0.48	76
3.20 E-01	0.32	20/63	6/19	0.50	75
3.00 E-01	0.3	20/66	6/20	0.52	74
2.90 E-01	0.28	20/70	6/21	0.54	73
2.75 E-01				0.56	72
2.63 E-01				0.58	71
2.50 E-01	0.25	20/80	6/24	0.60	70
2.40 E-01				0.62	69
2.30 E-01				0.64	68
2.20 E-01				0.66	67
2.10 E-01				0.68	66
2.00 E-01	0.2	20/100	6/30	0.70	65
1.90 E-01				0.72	64
1.82 E-01				0.74	63
1.74 E-01				0.76	62
1.66 E-01	0.17	20/120	6/36	0.78	61
1.60 E-01	0.16	20/125	6/38	0.80	60
1.50 E-01	0.15	20/130	6/40	0.82	59
1.45 E-01				0.84	58
1.38 E-01				0.86	57
1.30 E-01	0.13	20/150	6/45	0.88	56
1.25 E-01	0.125	20/160	6/48	0.90	55
1.20 E-01	0.12	20/170	6/50	0.92	54
1.15 E-01				0.94	53
1.10 E-01				0.96	52
1.05 E-01				0.98	51
1.00 E-01	0.1	20/200	6/60	1.00	50

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9.55 E-02				1.02	49
9.00 E-02				1.04	48
8.70 E-02				1.06	47
8.30 E-02	0.083	20/240	6/72	1.08	46
8.00 E-02	0.08	20/250	6/75	1.10	45
7.50 E-02				1.12	44
7.20 E-02				1.14	43
7.00 E-02				1.16	42
6.60 E-02	0.065	20/300	6/90	1.18	41
6.30 E-02	0.063	20/320	6/95	1.20	40
6.00 E-02	0.06	20/330	6/100	1.22	39
5.75 E-02				1.24	38
5.50 E-02				1.26	37
5.25 E-02				1.28	36
5.00 E-02	0.05	20/400	6/120	1.30	35
4.80 E-02				1.32	34
4.60 E-02				1.34	33
4.40 E-02				1.36	32
4.20 E-02				1.38	31
4.00 E-02	0.04	20/500	6/150	1.40	30
3.80 E-02				1.42	29
3.60 E-02				1.44	28
3.50 E-02				1.46	27
3.33 E-02				1.48	26
3.20 E-02	0.032	20/630	6/190	1.50	25
3.02 E-02	0.03	20/650	6/200	1.52	24
2.90 E-02				1.54	23
2.75 E-02				1.56	22
2.63 E-02				1.58	21
2.50 E-02	0.025	20/800	6/240	1.60	20
2.40 E-02				1.62	19
2.30 E-02				1.64	18
2.20 E-02				1.66	17
2.10 E-02				1.68	16
2.00 E-02	0.02	20/1000	6/300	1.70	15
1.90 E-02				1.72	14
1.82 E-02				1.74	13
1.74 E-02				1.76	12
1.66 E-02				1.78	11
1.60 E-02	0.016	20/1250	6/380	1.80	10
1.50 E-02	0.015	20/1300	6/400	1.82	9
1.45 E-02				1.84	8

1.38 E-02				1.86	7
1.30 E-02				1.88	6
1.25 E-02	0.0125	20/1600	6/480	1.90	5
1.20 E-02				1.92	4
1.15 E-02				1.94	3
1.10 E-02				1.96	2
1.05 E-02				1.98	1
1.00 E-02	0.01	20/2000	6/600	2.00	0

X.2.5 ETDRS Charts

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ETDRS charts feature Sloan letters with proportional spacing, 5 letters on each line, and a logarithmic progression of letter sizes with consistent increments of approximately 25% per line (10 lines equal a factor 10x). The ETDRS protocol specifies letter-by-letter scoring, viewing distance, illumination, use of different charts for right and left eye and other presentation parameters.

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The full ETDRS protocol requires a wide chart on a light box, and cannot be implemented on the limited screen of a projector (or similar) chart. The logarithmic progression, however, can be implemented on any device. This progression was first proposed by John Green in 1868 and follows the standard "Preferred Numbers, ISO standard 3 (1973)" series and the rounding preferences.

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Use of ETDRS charts allows use of letter-by-letter scoring, which is more accurate than the line-by-line scoring used on traditional charts. Each row in the table is equivalent to 1 letter on an ETDRS chart (50 letters for a factor 10x). These steps are smaller than the just discernable difference; steps this small only become significant in statistical studies where a large number of measurements is averaged.

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The smaller steps for letter by letter scoring may be expressed in two ways; either by using suffixes to a familiar (sometimes slightly rounded) set of values or by using calculated values. For clinical use suffixes have the advantage of using only familiar acuity notations and reverting to the nearest clinical notation when the suffix is omitted. Calculated values look less familiar; but are sometimes used in statistical studies. Note that suffixes used in the context of an ETDRS chart have a defined value and affect the DICOM storage value, whereas suffixes used in the context of traditional charts do not.

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TABLE X-2
Reference table for use with ETDRS CHARTS or equivalent

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DICOM	Notations for Research Use with ETDRS Charts or equivalent						Scales for statistics and graphical displays	
Decimal Visual Acuity	Use with suffixes			Calculated values			Linear Scales	
	Decimal	US	6 m	Decimal	US	6 m	LogMAR	VAS
2.00 E+00	2.0	20/10	6/3	2.00	20/10	6/3.0	-0.30	115

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1.91 E+00	-	-	-	1.91	20/10.5	6/3.2	-0.28	114
1.82 E+00	--	--	--	1.82	20/11	6/3.3	-0.26	113
1.74 E+00	++	++	++	1.74	20/11.5	6/3.5	-0.24	112
1.66 E+00	+	+	+	1.66	20/12	6/3.6	-0.22	111
1.60 E+00	1.6	20/12.5	6/3.8	1.58	20/12.5	6/3.8	-0.20	110
1.50 E+00	-	-	-	1.51	20/13	6/4.0	-0.18	109
1.45 E+00	--	--	--	1.45	20/14	6/4.2	-0.16	108
1.38 E+00	++	++	++	1.38	20/14.5	6/4.4	-0.14	107
1.30 E+00	+	+	+	1.32	20/15	6/4.6	-0.12	106
1.25 E+00	1.25	20/16	6/4.8	1.26	20/16	6/4.8	-0.10	105
1.20 E+00	-	-	-	1.20	20/17	6/5.0	-0.08	104
1.15 E+00	--	--	--	1.15	20/17.5	6/5.2	-0.06	103
1.10 E+00	++	++	++	1.10	20/18	6/5.5	-0.04	102
1.05 E+00	+	+	+	1.05	20/19	6/5.8	-0.02	101
1.00 E+00	1.0	20/20	6/6	1.00	20/20	6/6.0	0	100
9.55 E-01	-	-	-	0.95	20/21	6/6.3	0.02	99
9.00 E-01	--	--	--	0.91	20/22	6/6.6	0.04	98
8.70 E-01	++	++	++	0.87	20/23	6/6.9	0.06	97
8.30 E-01	+	+	+	0.83	20/24	6/7.2	0.08	96
8.00 E-01	0.8	20/25	6/7.5	0.79	20/25	6/7.5	0.10	95
7.50 E-01	-	-	-	0.76	20/26	6/7.9	0.12	94
7.20 E-01	--	--	--	0.72	20/28	6/8.3	0.14	93
7.00 E-01	++	++	++	0.69	20/29	6/8.7	0.16	92
6.60 E-01	+	+	+	0.66	20/30	6/9.1	0.18	91
6.30 E-01	0.63	20/32	6/9.5	0.63	20/32	6/9.5	0.20	90
6.00 E-01	-	-	-	0.60	20/33	6/10.0	0.22	89
5.75 E-01	--	--	--	0.58	20/35	6/10.5	0.24	88
5.50 E-01	++	++	++	0.55	20/36	6/11.0	0.26	87
5.25 E-01	+	+	+	0.52	20/38	6/11.5	0.28	86
5.00 E-01	0.5	20/40	6/12	0.50	20/40	6/12.0	0.30	85
4.80 E-01	-	-	-	0.48	20/42	6/12.5	0.32	84
4.57 E-01	--	--	--	0.46	20/44	6/13.2	0.34	83
4.37 E-01	++	++	++	0.24	20/46	6/13.8	0.36	82
4.17 E-01	+	+	+	0.42	20/48	6/14.5	0.38	81
4.00 E-01	0.4	20/50	6/15	0.40	20/50	6/15.1	0.40	80
3.80 E-01	-	-	-	0.38	20/52	6/15.8	0.42	79
3.60 E-01	--	--	--	0.36	20/55	6/16.6	0.44	78
3.50 E-01	++	++	++	0.35	20/58	6/17.4	0.46	77
3.33 E-01	+	+	+	0.33	20/60	6/18.2	0.48	76
3.20 E-01	0.32	20/63	6/19	0.32	20/63	6/19.1	0.50	75
3.00 E-01	-	-	-	0.30	20/66	6/20.	0.52	74
2.90 E-01	--	--	--	0.29	20/69	6/21	0.54	73

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2.75 E-01	++	++	++	0.28	20/72	6/22	0.56	72
2.63 E-01	+	+	+	0.26	20/76	6/23	0.58	71
2.50 E-01	0.25	20/80	6/24	0.25	20/79	6/24	0.60	70
2.40 E-01	-	-	-	0.24	20/83	6/25	0.62	69
2.30 E-01	--	--	--	0.23	20/87	6/26	0.64	68
2.20 E-01	++	++	++	0.22	20/91	6/28	0.66	67
2.10 E-01	+	+	+	0.21	20/95	6/29	0.68	66
2.00 E-01	0.2	20/100	6/30	0.20	20/100	6/30	0.70	65
1.90 E-01	-	-	-	0.191	20/105	6/32	0.72	64
1.82 E-01	--	--	--	0.182	20/110	6/33	0.74	63
1.74 E-01	++	++	++	0.174	20/115	6/35	0.76	62
1.66 E-01	+	+	+	0.166	20/120	6/36	0.78	61
1.60 E-01	0.16	20/125	6/38	0.158	20/126	6/38	0.80	60
1.50 E-01	-	-	-	0.151	20/132	6/40	0.82	59
1.45 E-01	--	--	--	0.145	20/138	6/42	0.84	58
1.38 E-01	++	++	++	0.138	20/145	6/44	0.86	57
1.30 E-01	+	+	+	0.132	20/151	6/46	0.88	56
1.25 E-01	0.125	20/160	6/48	0.126	20/158	6/48	0.90	55
1.20 E-01	-	-	-	0.120	20/166	6/50	0.92	54
1.15 E-01	--	--	--	0.115	20/174	6/52	0.94	53
1.10 E-01	++	++	++	0.110	20/182	6/55	0.96	52
1.05 E-01	+	+	+	0.105	20/191	6/58	0.98	51
1.00 E-01	0.1	20/200	6/60	0.100	20/200	6/60	1.00	50
9.55 E-02	-	-	-	0.095	20/210	6/63	1.02	49
9.00 E-02	--	--	--	0.091	20/220	6/66	1.04	48
8.70 E-02	++	++	++	0.087	20/230	6/69	1.06	47
8.30 E-02	+	+	+	0.083	20/240	6/72	1.08	46
8.00 E-02	0.08	20/250	6/75	0.079	20/250	6/76	1.10	45
7.50 E-02	-	-	-	0.076	20/260	6/79	1.12	44
7.20 E-02	--	--	--	0.072	20/280	6/83	1.14	43
7.00 E-02	++	++	++	0.069	20/290	6/87	1.16	42
6.60 E-02	+	+	+	0.066	20/300	6/91	1.18	41
6.30 E-02	0.063	20/320	6/95	0.063	20/315	6/95	1.20	40
6.00 E-02	-	-	-	0.060	20/330	6/100	1.22	39
5.75 E-02	--	--	--	0.058	20/350	6/105	1.24	38
5.50 E-02	++	++	++	0.055	20/360	6/110	1.26	37
5.25 E-02	+	+	+	0.052	20/380	6/115	1.28	36
5.00 E-02	0.05	20/400	6/120	0.050	20/400	6/120	1.30	35
4.80 E-02	-	-	-	0.048	20/420	6/126	1.32	34
4.60 E-02	--	--	--	0.046	20/440	6/132	1.34	33
4.40 E-02	++	++	++	0.044	20/460	6/138	1.36	32
4.20 E-02	+	+	+	0.042	20/480	6/145	1.38	31

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4.00 E-02	0.04	20/500	6/150	0.040	20/500	6/151	1.40	30
3.80 E-02	-	-	-	0.038	20/520	6/158	1.42	29
3.60 E-02	--	--	--	0.036	20/550	6/166	1.44	28
3.50 E-02	++	++	++	0.035	20/575	6/174	1.46	27
3.33 E-02	+	+	+	0.033	20/600	6/182	1.48	26
3.20 E-02	0.032	20/630	6/190	0.032	20/630	6/191	1.50	25
3.02 E-02	-	-	-	0.030	20/660	6/200	1.52	24
2.90 E-02	--	--	--	0.029	20/690	6/210	1.54	23
2.75 E-02	++	++	++	0.028	20/720	6/220	1.56	22
2.63 E-02	+	+	+	0.026	20/760	6/230	1.58	21
2.50 E-02	0.025	20/800	6/240	0.025	20/800	6/240	1.60	20
2.40 E-02	-	-	-	0.024	20/830	6/250	1.62	19
2.30 E-02	--	--	--	0.023	20/870	6/260	1.64	18
2.20 E-02	++	++	++	0.022	20/910	6/280	1.66	17
2.10 E-02	+	+	+	0.021	20/950	6/290	1.68	16
2.00 E-02	0.020	20/1000	6/300	0.0200	20/1000	6/300	1.70	15
1.90 E-02	-	-	-	0.0191	20/1050	6/315	1.72	14
1.82 E-02	--	--	--	0.0182	20/1100	6/330	1.74	13
1.74 E-02	++	++	++	0.0174	20/1150	6/350	1.76	12
1.66 E-02	+	+	+	0.0166	20/1200	6/363	1.78	11
1.60 E-02	0.016	20/1250	6/380	0.0158	20/1250	6/380	1.80	10
1.50 E-02	-	-	-	0.0151	20/1300	6/400	1.82	9
1.45 E-02	--	--	--	0.0145	20/1380	6/420	1.84	8
1.38 E-02	++	++	++	0.0138	20/1450	6/440	1.86	7
1.30 E-02	+	+	+	0.0132	20/1500	6/460	1.88	6
1.25 E-02	0.0125	20/1600	6/480	0.0126	20/1600	6/480	1.90	5
1.20 E-02	-	-	-	0.0120	20/1660	6/500	1.92	4
1.15 E-02	--	--	--	0.0115	20/1740	6/520	1.94	3
1.10 E-02	++	++	++	0.0110	20/1820	6/550	1.96	2
1.05 E-02	+	+	+	0.0105	20/1910	6/575	1.98	1
1.00 E-02	0.010	20/2000	6/600	0.0100	20/2000	6/600	2.00	0