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Standard Specification for Eye Protectors for Women's Lacrosse[1]

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1. Scope

1.1 This specification covers eye protectors designed for use by players of women's lacrosse that minimize or significantly reduce injury to the eye and adnexa due to impact and penetration of lacrosse balls. Protective eyewear offers protection only to the eyes and does not protect other parts of the head.

1.2 Impact testing is done in a laboratory setting. Eye contact is determined by observation.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only. Metric units of measurement in this specification are in accordance with the International System of Units (SI). If a value for measurement as given in this specification is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate.

1.4 The following precautionary caveat pertains only to the test methods portion (Sections 8, 9, and 10) of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics
D2240 Test Method for Rubber Property—Durometer Hardness

2.2 *ANSI Standards:*[3]

ANSI Z80.1 Requirements for First-Quality Prescription Ophthalmic Lenses
ANSI Z80.3 Nonprescription Sunglasses and Fashion Eyewear Requirements
ANSI Z87.1 Occupational and Educational Personal Eye and Face Protection Devices

[1] This specification is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.57 on Eye Safety for Sports.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

2.3 *Federal Standard:*[4]
National Institute of Standards and Technology Special Technical Publication 374 Method for Determining the Resolving Power of Photographic Lenses

2.4 *Canadian Standard:*[5]
CSA Z262.6-14 Specifications for Facially Featured Head Forms

2.5 *NOCSAE Standard:*[6]
NOCSAE (ND) 049 Standard Performance Specification for Newly Manufactured Lacrosse Balls

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *binocular, adj*—relating to the field of view which is shared by both eyes simultaneously; also any simultaneous activity of the two eyes.

3.1.2 *central viewing zone, n*—that part of the eye of a protector which has its center in line with the wearer's normal line of sight.
3.1.2.1 *Discussion*—
The zone is circular in shape, and 40 mm in diameter. The center of the central viewing zone shall be the point of intersection of the line of sight with the lens as mounted on the CSA headform. (See CSA Z262.6.)

3.1.3 *cleanable, n*—ability of a protective device to be made readily free of dirt or grime without being damaged during an appropriate cleaning process, such as the use of soap and water.

3.1.4 *coverage, n*—characteristic of a protective device that obstructs straight line paths that are coincident with the wearer's eyes.

3.1.5 *definition (optical), n*—characteristic of a lens that allows separate distinct points in close proximity to be discerned when looking through the lens.

3.1.6 *eye, n*—relating to the eye of a test headform or the eye of a person wearing a protector or that part of an eye protective device through which a wearer's eye would normally look.

3.1.7 *eye of the headform, n*—all structures contained within the orbital rim of the CSA headform. (See CSA Z262.6.)

3.1.8 *haze, n*—fraction of the total transmitted light from a normally incident beam which is not transmitted in a focused condition but scattered by inclusions or surface defects.
3.1.8.1 *Discussion*—
Excessive haze will reduce contrast and visibility.

3.1.9 *headform optical parameters, n*—key dimensions for the head forms.

3.1.10 *impact resistance, n*—the ability of a device to afford protection from impact as required by this specification.

3.1.11 *lens, n*—when so equipped, the transparent part or parts of a protective device through which the wearer normally sees.

3.1.12 *luminous transmittance, n*—function of the spectral transmittance of the lens weighted by the corresponding ordinates of the photopic luminous efficiency distribution of the CIE (1931) standard colorimetric observer and by the spectral intensity of standard Illuminant C. (See ANSI Z80.3, Paragraph 3.9.1.)

3.1.13 *normal lines of sight, n*—straight ahead horizontal lines that intersect the center of the eyes of the appropriate headform.

3.1.14 *penetration resistance, n*—the ability of a device to afford protection from moving objects as required by this specification.

[4] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.
[5] Available from Canadian Standards Association (CSA), 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, http://www.csa.ca.
[6] Available from the National Operating Committee on Standards for Athletic Equipment (NOCSAE), http://www.nocsae.org.

3.1.15 *plano lens, n*—a lens that does not incorporate a corrective prescription. This lens is not necessarily flat.

3.1.16 *power imbalance, n*—relates to the condition in which the refractive power of the lens or lenses of a protector is different as presented to the two eyes.

3.1.17 *prescription (corrective) lens carrier, n*—a lens housing (frame) for mounting prescription lenses behind the lens or non-lens (cage) of a Type I or Type III protective eyewear device as subject to this standard to provide for corrected vision of the wearer.

3.1.17.1 *Discussion—*

The carrier housing itself is affixed to the interior of the primary protective device.

3.1.18 *prism, n*—a device that bends a beam of light as a result of the lack of parallelism of the two surfaces of a lens through which the beam of light traverses.

3.1.18.1 *Discussion—*

The amount of bending is a function of the curvatures, thickness, index of refraction of the material and the angle of approach of the line of sight to the optical surface. In this specification, prism refers to the amount of bending that is imposed upon the line of sight of a wearer of an eye protector for the specified viewing position. Prism is expressed in diopters. The deviation of the line of sight by 1 cm/m is one prism diopter.

3.1.18.1 *base-in, n*—relating to the type of prism imbalance that tends to cause parallel rays of light passing through a protector, spaced apart by the inter-pupillary distance, to converge.

3.1.18.2 *base-out, n*—relating to the type of prism imbalance that tends to cause parallel rays of light passing through a protector, spaced apart by the inter-pupillary distance, to diverge.

3.1.18.3 *base-up, n*—refers to the type of prism that causes a horizontal beam of light to bend upward causing objects to appear lower than their true position.

3.1.18.4 *base-down, n*—refers to the type of prism that causes a horizontal beam of light to bend down causing objects to appear higher than their true position.

3.1.19 *prism imbalance, n—*

3.1.19.1 *horizontal imbalance, n*—difference in prismatic deviation of incident parallel light beams on the two eyes of a protective device in the horizontal meridian. (See *base-in* and *base-out*.)

3.1.19.2 *vertical imbalance, n*—difference in prismatic deviation between parallel light beams incident on the two eyes of a protective device in the vertical meridian.

3.1.20 *protective device (or protector), n*—device that provides protection to the wearer's eye against specific hazards encountered in sports.

3.1.21 *refractive power, n*—focusing effect of a lens expressed in diopters.

3.1.21.1 *astigmatism, n*—condition in a lens that creates two axially separated line foci of each object point, the lines being mutually perpendicular. In other words, the lens has two different refractive powers in meridians that are 90° apart.

3.1.22 *scotoma, n*—blind or partially blind area within the visual field.

3.1.23 *spherical power, n*—the average of the maximum meridional astigmatic power and the minimum meridional astigmatic power of a lens.

4. Classification

4.1 Eye protectors are classified into the following types:

4.1.1 *Type I*—A protector with the lens or lenses and frame front piece molded as one unit. Frame temples or other devices, such as straps, to affix the lens/front piece may be separate pieces.

4.1.2 *Type II*—A protector with a single lens or lenses, either plano or prescription, mounted in a frame that was manufactured as a separate unit.

4.1.3 *Type III*—A protector without a lens.

5. General Requirements

5.1 *Materials of Construction:*

5.1.1 The manufacturer's choice of material shall be in accordance with 5.1.2 and 5.1.3.

5.1.2 Materials coming into contact with the wearer's face shall not be of a type known to cause skin irritation.

5.1.3 Materials coming into contact with the wearer's face, except replaceable padding, shall not undergo significant loss of strength or flexibility, or other physical change as a result of perspiration, oil, or grease from the wearer's skin and hair.

5.1.3.1 Manufacturer will provide material selection and, by affidavit, support 5.1.1 – 5.1.3.

5.1.4 *Cleanability*—Protective devices shall be capable of being cleaned to the degree that when conditioned in accordance with the method described in 9.1, they shall remain functional in all ways.

5.2 *Finishes and Construction*—The protector shall be constructed in a manner to prevent the missile or components of the protector from contact with the eye of the headform when tested in accordance with Section 10.

5.3 Straps are not required on eye protectors, provided the protector passes the standard without straps.

6. Performance Requirements

6.1 *Optical Requirements—Type I and II Protectors:*

6.1.1 *Refractive Tolerances*—When tested in accordance with 8.5, maximum refractive power in any meridian shall not exceed +0.12 or –0.2 diopters. Spherical power shall be within the range of +0.06 diopters to –0.18 diopters.

6.1.2 *Astigmatism*—When tested in accordance with 8.5, the astigmatism shall not exceed 0.12 diopter.

6.1.3 *Power Imbalance*—When tested in accordance with 8.5, the power imbalance in corresponding meridians shall not exceed 0.18 diopters between the two eyes for straight-ahead seeing.

6.1.4 *Prism*—For the primary viewing position of either eye of a shield or pair of lenses, the prism deviation shall not exceed 0.50 prism diopters when tested in accordance with 8.3.

6.1.5 *Prism Imbalance:*

6.1.5.1 *Vertical and Base-In*—0.25 prism diopters.

6.1.5.2 *Base-Out*—0.50 prism diopters.

6.1.6 *Luminous Transmittance*—When tested in accordance with 8.2, protectors shall have a luminous transmittance of not less than 85 % for a clear device and not less than 20 % for tinted devices. Additionally, the difference in values as would be viewed by the two eyes through a single protector as worn shall not exceed 0.9 to 1.1 times the other value (measured at the design line of sight) unless specifically prescribed by an ophthalmic professional.

6.1.7 *Ultraviolet Transmittance*—UVB (290–315 nm), clear protectors, 5 % maximum, sunglass types, 1 % maximum. UVA (315–380 nm), clear protectors, 50 % maximum, sunglass types, 0.5 luminous transmittance.

6.1.8 *Haze*—When tested in accordance with 8.4, the haze in the protector shall not exceed 3 %.

6.1.9 Lenses that exhibit any distortion or doubling of the image during the test for refractive power or prism shall be further tested in accordance with 8.1.

6.1.10 *Optical Quality*—Within the central viewing zone, striae warpage, surface ripples, lenticulations, or abrupt optical changes that are visible under the test conditions of 8.1 and that would impair the function of the lens shall be cause for rejection. Visual impairment is defined by the scanning and focimeter test of 8.1.

6.1.11 *Surface and Internal Defects*—Pits, scratches, bubbles, grayness, specks, cracks, and water marks that are visible under the test conditions of 8.6 and that would impair the function of the lens shall be a cause for rejection. Grayness should be evaluated by the requirements of 6.1.6.

6.2 *Mechanical Requirements:*

6.2.1 No contact with the eye of the headform shall be permitted when tested in accordance with ~~Section 10~~10.1.

6.2.2 When tested in accordance with ~~Section 10~~10.1, displaced fragments or complete fracture of any components of the eye protector excluding padding constitutes a failure.

6.2.3 When tested in accordance with ~~Section 10~~10.1, any displacement of the lens from the frame and that contacts the eye, constitutes a failure.

6.2.4 A protector that is dislodged from the test headform when tested in accordance with ~~Section 10~~10.1 shall not constitute a failure, provided all of the above mechanical requirements are met.

6.3 *Requirements for Frames to be Fitted With Rx (Corrective) Lenses:*

6.3.1 Frames intended to be used for prescription lenses shall be tested to the requirements of 6.2 with ~~plano, highest plus~~ representative test lenses of plano, and the highest plus effective sphere power and lowest minus effective sphere power as desired to be qualified by the manufacturer. Each lens material(s)/ manufacturer(s), surface treatment (for example, coating) and finishing process as desired to be qualified for laboratory finishing. If all test lenses pass, than any prescription lens of the same of greater thickness at it thinnest point within the prescription range tested and qualified which is made of the same material(s)/ manufacturer(s), with the same surface treatment (coatings) and finishing processes may be approved for use with that frame.

6.3.2 Optical Finishing laboratories shall only fit lenses into protector frames within the highest plus and lowest minus sphere power as qualified for the frame in accord with the minimum thickness, material(s), manufacturer(s) and surface treatment(s) which were qualified and approved for use with the protector ~~(frame)~~frame in ~~accordance with lenses glazed into frames shall be within the demonstrated diopter which the frame was qualified for.~~accord with those instructions as provided by the frame manufacturer (as required by this standard).

6.3.3 Finished (glazed) lenses shall comply with current requirements as set forth in ANSI ~~Z80.1.~~Z80.1 with the exception of drop ball requirements which shall be qualified as in 6.3.

6.4 *Requirements for Prescription (corrective) Lens Carriers:*

6.4.1 Prescription lens carrier systems (frames and lenses) shall meet the requirements of both 6.4.2 and 6.4.3.

6.4.2 *Requirements for Prescription (corrective) Lenses used in Prescription Lens Carriers:*

6.4.2.1 *Requirements for Lenses use in Prescription (corrective) Carriers:*

(1) Lenses intended to be used in prescription carriers shall be qualified for drop ball impact resistance as in accordance with 10.3. Three lenses of each effective sphere power (highest plus and lowest minus) shall be tested.

(2) Lenses intended to be used in prescription carriers shall be tested and qualified to the requirements of 10.3 with lenses of the highest plus effective sphere power and lowest minus effective sphere power as desired to be qualified by the manufacturer for use in the prescription lens carrier. The representative test lenses shall be of the minimum thickness, material(s)/manufacturer(s), surface treatment (for example, coating) and finishing process as desired to be qualified for laboratory finishing in the prescription lens carrier.

(3) When tested in accordance with 10.3, the lens shall be capable of resisting impact by a 25.4 mm (1. in.) diameter steel ball when dropped freom a height of 127 cm (50 in.). The lens shall not fracture as a result of this test.

(4) When tested to the requirements of 10.3, if all test lenses pass, then any prescription lens of the same of greater thickness at it thinnest point within the prescription range tested and qualified which is made of the same material(s)/manufacturer(s), with the same surface treatment (coatings) and finishing processes may be utilized for use with the prescription lens carrier that has itself been tested and qualified with a lens of the same properties in accordance with 6.2.

6.4.3 *Requirements for Prescription (corrective) Lens Carrier Frames:*

6.4.3.1 Protectors intended to incorporate prescription lens carriers shall be tested to the requirements in 6.2 with representative test lenses of the highest plus effective sphere power and lowest minus effective sphere power as desired to be qualified by the manufacturer. The representative test lenses shall be of the minimum thickness, material(s)/manufacturer(s), surface treatment (for example, coating) and finishing process as desired to be qualified for laboratory finishing.

6.4.3.2 Each protector model intended to allow incorporation of a lens carrier shall be tested to the full requirements in 6.2.

6.4.3.3 Prescription lens carriers not manufactured or sold, or both, by the protective device frame manufacturer shall not be used and are prohibited by this standard.

6.4.3.4 When tested to the requirements in 6.2, if all protectors pass, then that protector model and prescription lens carrier model combination as fitted with any prescription lens of the same of greater thickness at it thinnest point within the prescription range tested and qualified which is made of the same material(s)/manufacturer(s), with the same surface treatment (coatings) and finishing processes may be approved for use with that frame.

6.4.3.5 Optical Finishing laboratories shall only fit lenses into prescription lens carrier frames within the highest plus and lowest minus sphere power as qualified for the frame in accord with the minimum thickness, material(s)/manufacturer(s) and surface treatment(s) which were qualified and approved for use with the protector (frame) in accord with those instructions as provided by the frame manufacturer.

6.4.3.6 Finished (glazed) lenses shall comply with current requirements as set forth in ANSI Z80.1 with the exception of drop ball requirements which shall be qualified as in 10.3.

6.4.3.7 Optical Finishing laboratories shall only fit lenses into prescription lens carrier frames within the highest plus and lowest minus sphere power as qualified for the frame in accord with the minimum thickness, material(s)/manufacturer(s) and surface treatment(s) which were qualified in accord with 10.3 and 6.4.2 of this standard and approved for use with the protector (frame) in accord with those instructions as provided by the frame manufacturer (as required by this standard).

7. Sample Preparation

7.1 Only new and complete eye protectors as offered for sale shall be tested.

7.2 Protectors shall be conditioned and tested at two temperatures, 39 ± 2°C and –2 ± 2°C for a minimum of 4 h prior to mechanical testing. For the purpose of this standard, four protectors are tested at 39 ± 2°C and four protectors at –2 ± 2°C.

TEST METHODS

8. Optical Tests

8.1 *Optical Quality*—Localized power errors or aberrations that are detected by the visual inspection procedure of 8.1.1 are permissible if no measurable or gross focimeter or telescope target distortion or blur is found when the localized area is examined with an instrument as indicated in 8.1.2.

8.1.1 *Inspection Procedure*—One method of optical inspection is to view a high-contrast grid pattern of dark and white lines through the lens, scanning it area by area and moving it about. The grid pattern should be at least 18 by 18 in. and constructed of high contrast black lines on a white background (the white separations being equal to the black lines, both being approximately ¼ in. wide). The target should be at least 6 to 8 ft from the observer, and the lens should be held at least 18 to 24 in. from the eye. Any ripples in the lens detected by this test method should be further examined in accordance with 8.1.2.

8.1.2 The referee method of detecting optical defects and local aberrations is to scan the central viewing zone, especially areas of suspicion arising from the visual test of 8.1.1. The lens or shield should be scanned with a precision focimeter or an 8× to 10×

telescope using the targets and arrangements described in 8.5.2. The aperture should be 5 to 7 mm for this examination. Areas outside the central viewing zone or within 6 mm of the edge need not be tested. When the central viewing area is scanned, there shall be no sudden jump, doubling, or blurring of the image greater than 0.08 diopters change in power. Gradual variations in the central viewing zone shall be within the power imbalance tolerances. An optical focimeter with electronic readout repeatable to 0.02 diopters is a satisfactory alternate method. These scanning procedures may be made by scanning across the lens surface not necessarily in the "as worn" mode.

8.2 *Luminous Transmittance*—Use a suitable photometer, such as a Gardner Hazemeter, or other device comprised of a light source of CIE Illuminant A at 2856°K color temperature, and a photometric probe and meter capable of reading transmission in percent over a range of 1 to 100 %. Use a suitable enclosure to block against stray light and contain the test samples. Following the manufacturers instructions for the use of the instrument, measure the specimen for percent transmittance within each of the two central viewing zones. The measured values shall meet the established criteria for the device. A spectrophotometer, followed by appropriate photometric calculation, may also be used.

8.2.1 For the purposes of this specification, luminance transmittance may be measured with inexpensive photometers.[7] A fixturing device should be devised to exclude ambient light. The source need not be strictly Illuminate C. A tungsten lamp or a screw-in fluorescent lamp provides adequate simulation of the use environment.

8.2.2 *Ultraviolet Transmittance*—Use a commercially available spectrophotometer with average transmittances measured in no greater than 10 nm bandwidths.

8.3 *Prismatic Deviation Measurements:*

8.3.1 *Purpose*—The test presented here is intended to measure the angular deviation of light rays created by the protective device as they pass through the lens(es).

8.3.2 *Apparatus*—A telescope, equipped with a cross hair reticule having a magnification of 8× to 10× and an aperture 19 mm in diameter shall be used. The test method outlined in ANSI Z87.1-1989 has been found satisfactory for this purpose. Other methods that yield comparable results may be used. For this test method the target distance is 4 m. This is easier to achieve than longer distances. The target can be metric graph paper divided into 1 cm and 5 mm squares or constructed with a ruler and compass. A circle with a 2 cm radius and a center dot about 1.5 mm in diameter will provide the tolerance for overall prism in one eye. If the 1 cm and 5 mm grids are darkened for 20 mm in each direction from center, with the center lines emphasized, measurements will be easier. Each 5 mm of the scale represents 0.125 prism diopters. The prism values off-center can be labeled along one edge of the 4 cm square vertically and horizontally departing from the central zero. The right side of the target should be labeled plus (+) and the left side minus (–) and vertical top plus (+) and bottom minus (–).

8.3.3 *Test Procedure*—The eye protector shall be mounted either on an appropriate sized, adopted headform or in a fixture so that the axis of the test instrument is aligned with the normal line of sight as defined in 3.1.13. An appropriate standard head with parallel horizontal holes drilled through the eyes would be convenient, but in some cases unnecessary. A fixture with a board and dowel sticks can be devised to reproduce the alignment observer on a standard head. The inter-pupillary distance must match that of headform as the device is mechanically tested on. The fixture or head should be mounted on a bench or table. A single telescope can be used for straight ahead monocular readings. The fixture for holding the protector can be slotted to move from one eye to the other through the proper inter-pupillary distance. The telescope should be focused on the target at 4 m and aligned carefully with the cross hairs on the zero point of the target. A two-meridian screw adjustment will help. The readings for the vertical and horizontal prism for both eyes must be recorded. The monocular prism test is achieved by noting whether the cross hairs remain in the 20-mm circle. Each 5 mm equals 0.125 prism diopters. For the prism imbalance test, readings in prism diopters for each eye must be taken. This is done by recording the amount and direction of displacement of the cross hairs on the target. Apparent movement of the cross hairs in the plus direction is base-out for the right eye and base-in for the left eye whether or not reversed by the telescope. The same is true for vertical measurements. Record the apparent position of the cross hairs on the target with plus and minus signs, in terms of prism diopters. Subtract the left eye readings from the right eye readings. For vertical prism imbalance the absolute value of the resulting figure is the imbalance. For horizontal prism imbalance, a net positive value indicates the base-out prism imbalance. A net negative value indicates base-in prism imbalance.

[7] The sole source of supply of photometers known to the committee at this time is Edmund Scientific Corp. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.