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An American National Standard

Standard Specification for Eye Protectors for Racket Sports (Racquetball, Squash, Tennis)[1]

This standard is issued under the fixed designation F3164; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers eye protectors, designed for use by players of racket sports (racquetball, squash, tennis), that minimize or significantly reduce injury to the eye and adnexa due to impact and penetration by racket-sport rackets and balls. Protective eyewear offers protection only to the eyes and does not protect other parts of the head.

1.2 Protectors are divided into three types depending on their design characteristics.

1.3 This specification applies to eye protectors for use by wearers of corrective lenses and also by those players who do not require prescription eyewear. (**Warning—**Polycarbonate or Trivex spectacle lenses should be used if spectacles are worn under protective eyewear.)

1.4 In this standard, the use of the words “shall” or “must” indicates a mandatory requirement. The word “should” indicates a recommendation.

1.5 Failure of the product occurs when the protector is unable to meet the general, mechanical, and optical (if applicable) requirements of the standard.

1.6 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.

1.7 The following precautionary caveat pertains only to the test methods portions, Sections 9 – 11, 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.*

1.8 *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]

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

F1776 Specification for Eye Protective Devices for Paintball Sports

2.2 *American National Standards:*[3]

ANSI Z80.1 Recommendations for Prescription Ophthalmic Lenses

ANSI Z80.3 Requirements for Nonprescription Sunglasses and Fashion Eyewear

ANSI Z87.1 Practice for Occupational and Educational Eye and Face Protectors

2.3 *Federal Standard:*

National Institute of Standards and Technology Special Technical Publication 374 Method for Determining the Resolving Power of Photographic Lenses (1973)[4]

2.4 *Canadian National Standard:*

CAN/CSA-Z262.6-14 Specifications for facially featured headforms[5]

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.

[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.

[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), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, http://www.csagroup.org.

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.[5]

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

3.1.5 *definition (optical), n*—the 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.[5]

3.1.8 *fracture, n*—separation, as a result of impact, of any part of a protector resulting either in two completely separate pieces or the separation of a protector or part of a protector intended as a continuous single piece.

3.1.9 *haze, n*—the 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. Excessive haze will reduce contrast and visibility.

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*—luminous transmittance is a 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, 2015, Paragraph 3.8.1.)

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.

3.1.15 *permanent, adj*—marked so as not to become unidentifiable with normal usage.

3.1.16 *power imbalance, adj*—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 *prism, n*—a prism 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.

3.1.17.1 *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.

3.1.17.1 *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 interpupillary distance, to converge.

3.1.17.2 *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 interpupillary distance, to diverge.

3.1.17.3 *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.

3.1.17.4 *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.

3.1.18 *prism imbalance:*

3.1.18.1 *horizontal imbalance, n*—the 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*.)

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

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

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

3.1.20.1 *astigmatism, n*—a 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.

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

3.1.22 *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 frontpiece molded as one unit. Frame temples or other devices, such as straps, to affix the lens/frontpiece 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.

4.1.4 *Type IV*—A full or partial face shield.

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 by an affidavit submitted to the test agency which supports subsections 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 10.1, 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 11.

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:*

NOTE 1—Type IV protectors, full or partial face shields, shall conform to the optical requirements of Specification F1776.

6.1.1 *Refractive Tolerances*—When tested in accordance with 9.5, maximum refractive power in any meridian shall not exceed +0.12 or –0.2 diopters. Spherical power shall be in the range of +0.06 diopters to –0.18 diopters.

6.1.2 *Astigmatism*—When tested in accordance with 9.5, the astigmatism shall not exceed 0.12 diopter.

6.1.3 *Power Imbalance*—When tested in accordance with 9.5, 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 9.3.

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 9.2, 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*—When tested in accordance with 9.2, protectors shall meet the UV A and UV B requirements set forth in ANSI Z80.3.

6.1.8 *Haze*—When tested in accordance with 9.4, 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 9.1.

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 9.1 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 9.1.

6.1.11 *Surface and Internal Defects*—Pits, scratches, bubbles, grayness, specks, cracks, and water marks that are visible under the test conditions of 9.6 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 11.

6.2.2 When tested in accordance with Section 11, displaced fragments or complete fracture of the frame or lenses constitutes a failure.

6.2.3 When tested in accordance with Section 11, any displacement of the lens from the frame constitutes a failure.

6.2.4 A protector that is dislodged from the test headform when tested in accordance with Section 11 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 sphere power and lowest minus 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 or 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) in accordance with lenses glazed into frames shall be within the demonstrated diopter which the frame was qualified for.

6.3.3 Finished (glazed) lenses shall comply with current requirements as set forth in ANSI Z80.1.

7. Sample Preparation

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

7.2 Protectors shall be conditioned at 23 ± 2°C for a minimum period of 4 h prior to mechanical tests.

8. Product Marking

8.1 All eye protectors shall bear the following permanent markings (Type II protectors with Rx lenses shall be provided with documentation consisting of: copy of the Rx, lens material type, and dispensing or finishing laboratory, or both, name and address):

8.1.1 Manufacturer's identity,

8.1.2 Eye protector model identity, and

8.2 A label or tag bearing the following information shall be securely attached to, or accompany, each eye protector at time of sale:

8.2.1 Month and year of manufacture.

8.2.2 Clear and prominent markings providing sizing guidance—that is, gender, age, or size (small, medium, large), or a combination thereof.

8.2.3 A warning stating which cleaning and antifog agents may be used with eye protectors incorporating clear plastic shields and further stating that the lenses should be replaced when scratches become troublesome, or if cracks appear at the edges.

8.2.4 A warning stating that if the eye protector is severely impacted then the degree of protection provided may be reduced and the eye protector must be replaced. Failure to do so may result in permanent injuries to the eye.

8.2.5 A warning stating that if a lens pops out due to impact during play, the wearer should stop playing and have the protector replaced.

8.2.6 A warning statement that if the eye protector is stored at cold temperatures it should be allowed to return to room temperature before use.

8.2.7 A clear statement that the eye protector has been tested and is in compliance with Specification F3164-19 for eye protectors for (specify racquetball, squash or tennis).

8.2.8 A warning statement that the product cannot protect against all eye and facial injuries, or brain injuries, the user might suffer while participating in racket sports.

8.2.9 Frames intended to be fitted with Rx (corrective) lenses shall be provided (by the frame manufacturer) with instructions to the optical finishing laboratory which specify (at minimum): minimum lens thickness, the highest plus and lowest minus sphere power range, detailed specifications on the required bevel design or mounting technique, approved lens material(s)/manufacturer(s) and associated surface treatments and finishing processes allowable to be used with the frame.

TEST METHODS

9. Optical Tests

9.1 *Optical Quality*—Localized power errors or aberrations that are detected by the visual inspection procedure of 9.1.1 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 9.1.2.

9.1.1 *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 9.1.2.

9.1.2 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 9.1.1. The lens or shield should be scanned with a precision focimeter or an 8× to 10× telescope using the targets and arrangements described in 9.5.2 to 9.5.5. 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.

9.2 *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.

9.2.1 For the purposes of this specification, luminance transmittance may be measured with inexpensive photometers.[6] 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.

9.2.2 *Ultraviolet Transmittance*—Average transmittances are measured in no greater than 10 nm band widths with a commercially available spectrophotometer.

9.3 *Prismatic Deviation Measurements:*

9.3.1 *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).

[6] The sole source of supply of the 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.