Designation: F 1776 – ~~99a~~01

An American National Standard

Standard Specification for Eye Protective Devices for Paintball Sports[1]

This standard is issued under the fixed designation F 1776; 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.

INTRODUCTION

This is the specification for eye protective devices, or EPD, to be used in the sport of paintball. Paintball is a sport that, like all sports, has intrinsic hazards. These hazards include being hit by paintballs. Protective equipment cannot eliminate all injuries but will substantially reduce their severity and frequency. Participation in this sport by a player implies acceptance of injury risk. The goal of protective equipment is to minimize the risk of injury.

Performance requirements are presented and are intended to minimize injury with minimal impairment of the form and appeal of the sport. This specification is subject to revision as indicated by subsequent injury statistics.

The impact requirements are designed to give eye and adnexal protection from paintball impacts likely to be encountered under game conditions. While the EPD also may protect the user from other potential impacts, such as running into tree branches, there are many conceivable impacts, including falls from heights, which could exceed the specification and result in eye injury despite the use of the EPD.

1. Scope

1.1 This specification applies to eye protective devices, designed for use by players of the sport of paintball, that minimize or significantly reduce injury to the eye and adnexa due to impact and penetration of paintballs.

1.2 Eye protective devices meeting the requirements of this specification offer protection to the eyes and adnexa and not necessarily to any other parts of the head.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 This specification does not limit the wearing of eyeglasses or contact lenses when used in conjunction with the EPD.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics[2]

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[1] This specification is under the jurisdiction of ASTM Committee F~~-~~08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.57 on Eye Safety for Sports.

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F 803 Specification for Eye Protectors for Use by Players of Racquet Sports[3]

2.2 *ANSI Standards:*

Z80.3 Requirements for Nonprescription Sunglasses and Fashion Eyewear[4]

Z87.1 Practice for Occupational and Educational Eye and Face Protectors[4]

2.3 *Federal Standards:*[5]

No. 406

No. 3022

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *adnexa, n*—adjunct parts of the eye, including the orbit, orbital contents, eyelids, and the lacrimal apparatus.

3.1.2 *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.

3.1.3 *base-in, adj*—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.

3.1.4 *base-out, adj*—relating to the type of prism imbalance that tends to cause parallel rays of light passing through an EPD, spaced apart by the interpupillary distance, to diverge.

3.1.5 *binocular, adj*—relating to the field of view that is shared by both eyes simultaneously.

3.1.6 *central viewing zone, n*—that part of a lens that has its center in line with the wearer's line of sight when looking straight ahead. The zone is circular in shape. For the purpose of this specification, it shall be considered to be 38 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 ~~Alderson 50th percentile~~ CSA adult[6] ~~or CSA adult[7] headform.~~ headform, as specified by the manufacturer.

3.1.7 *cleanable, adj*—the ability of an EPD 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.

3.1.8 *coverage, n*—a characteristic of an EPD that protects the eyes by obstructing straight line paths that are coincident with the wearer's eyes.

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

3.1.10 *eye, n*—relating to the eye of the headform or the eye of a person wearing an EPD or that part of an EPD through which a wearer's eye would normally look.

3.1.11 *eye of the headform, n*—all structures contained within the orbital rim of the Alderson or CSA headform.

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

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

3.1.14 *headform optical parameters, n*—key dimensions for the headform as provided in Fig. 1.

3.1.15 *lens, n*—the transparent part of parts of an EPD through which the wearer normally sees.

3.1.16 *lens retention component(s), n*—components, separate from the lens, that are designed to retain the lens in the frame or body of the EPD.

3.1.17 *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 Illumination C (see ANSI Z80.3).

3.1.18 *paintball fragment, n*—a part of the shell of the paintball that will not be surrounded completely by a 3 by 5-mm rectangle .

3.1.19 *orbital area, n*—the area contained in a circle r = 20-mm centered on the pupil of the headform.

3.1.20 *power imbalance, n*—a condition that exists when the refractive power created by the right lens of the EPD is different from that of the left lens.

3.1.21 *prism, n*—the angular deviation of a ray of light as it passes through a lens resulting from the angle at which the ray strikes each surface of the lens and the index of refraction of the material from which it is made.

3.1.22 *prism imbalance*:

3.1.22.1 *horizontal imbalance, n*—the difference in prismatic deviation of incident parallel light beams on the two eyes of an EPD in the horizontal meridian (see **base-in** and **base-out**).

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

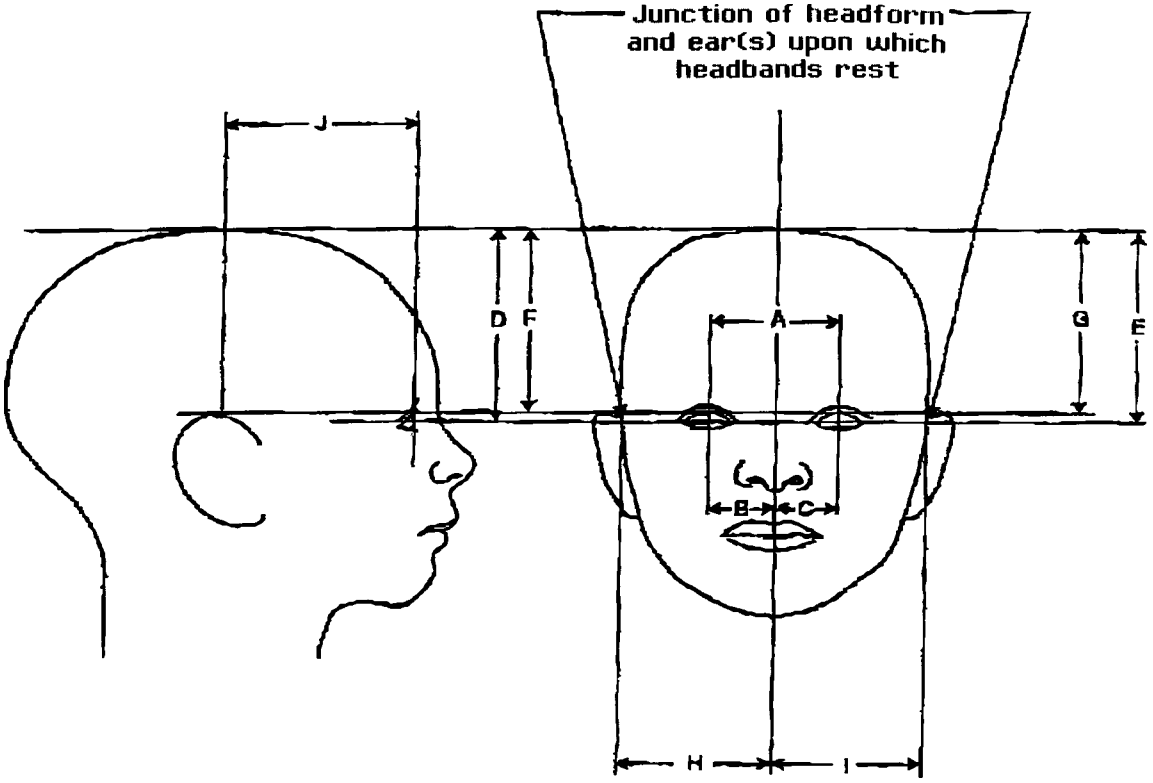
[3] *Annual Book of ASTM Standards*, Vol 15.07.

[4] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[6] Available from ~~FTSS, 47460 Galleon Drive, Plymouth, MI 48170.~~ CSA, 178 Rexdale Blvd., Rexdale, Toronto, Canada, M9W1R3.

[7] ~~Available from CSA, 178 Rexdale Blvd., Rexdale, Toronto, Canada, M9W1R3.~~ See *NIST Special Publication 374.*



Dimensions, mm	
~~A~~	~~= 2.60 ± 0.0 5 in. (66.0 ± 1.3 mm) 2 %~~
A	= 54.0 ± 2 %
~~B = C~~	~~= 1. 25± 0.03 in. (31.8 ± 0.8 mm) 2 %~~
B and C	= 27.0 ± 2 %
~~D = E~~	~~= 4.30 ± 0.10 in. (109. 2 ± 2.5 mm) %~~
D and E	= 95.0 ± 2 %
~~F = G~~	~~= 4.05 ± 0.10 in. (10 2.9 ± 2.5 mm) %~~
F and G	= 93.0 ± 2 %
~~H = I~~	~~= 3.10 ± 0.10 in. (78.7 ± 2.5 mm) %~~
H and I	= 66.0 ± 2 %
~~J~~	~~= 3.25 ±0.05 in. (82.6± 1.3 mm) 2 %~~
J	= 80.0± 2 %

~~Note 1—If headform is found to be symmetrical or is to be made symmetrical then B = C, D = E,~~ **F = G, and H = IG.**

A= Interpupillary~~distance.~~

1

CSA

8-Year~~distance.~~

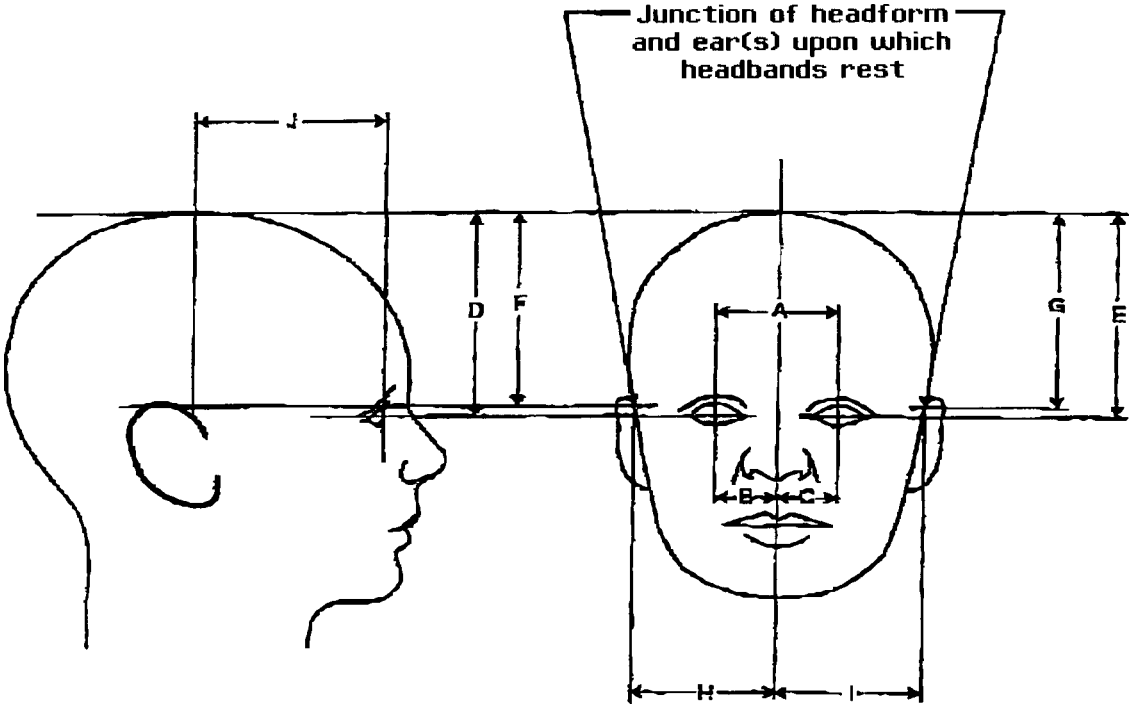
~~B = Distance of right eye pupil from sagittal plane.~~

B = Distance of right eye pupi Ol~~ from sagittal plane.~~

C~~= Distance of left eye pupil from sagittal plane.~~

d

C~~= Distance of~~



Dimensions, mm	
A	= 59.0 ± 2 %
B and C	= 29.5 ± 2 %
D and E	= 113.0 ± 2 %
F and G	= 108.0 ± 2 %
H and I	= 73.0 ± 2 %
J	= 85.0± 2 %

Note 1—If headform is found to be symmetrical or is to be made symmetrical then B = C, D = E, F = G, and H = I.

A = Interpupillary distance.
B = Distance of right eye pupil from sagittal plane.
C = Distance of left eye pupil from sagittal plane.
D = Distance of right eye pupil from top of headform.
E = Distance of left eye pupil from top of headform.
F = Distance of top of right ear/headform junction from top of headform.
G = Distance of top of left ear/headform junction from top of headform.
H = Distance from right side of headform to sagittal plane.
I = Distance from left side of headform to sagittal plane.
J = Distance between front of pupil and top of ear/headform junction.

FIG. 1 CSA 13 Year-Old Male/Adult Female *(continued)*

3.1.22.2 *vertical imbalance, n*—the difference in prismatic deviation between parallel light beams incident on the two eyes of an EPD in the vertical meridian.

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

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

4. Performance Requirements

4.1 *Optical Requirements*:

4.1.1 *Field of View*—When tested in accordance with 6.1, the EPD shall have a field of view equal to or exceeding the following:

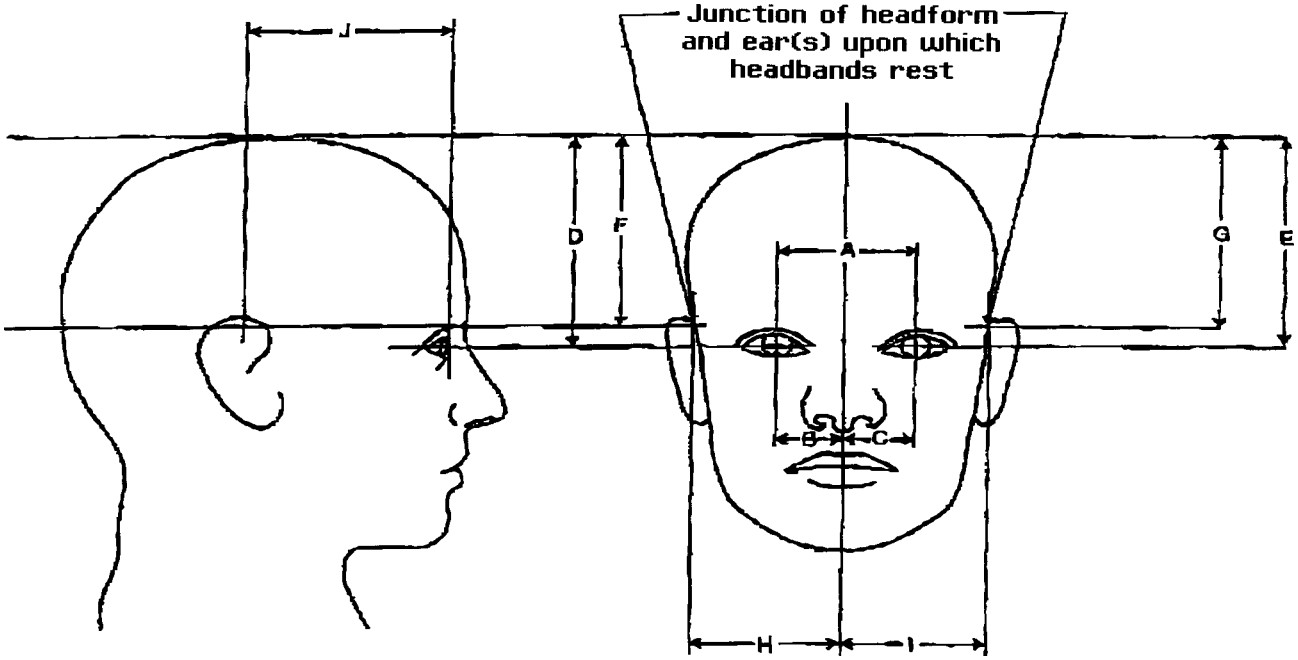
4.1.1.1 *Temporal Field*—50°.

4.1.1.2 *Nasal Field*—30°.

4.1.1.3 *Superior Field*—30°.

4.1.1.4 *Inferior Field*—30°.

4.1.2 *Refractive Tolerances*—When tested in accordance with 6.6, the spherical power shall not be less than −0.37 diopters and shall not exceed +0.06 diopters.



Dimensions, mm	
A	= 67.0 ± 2 %
B and C	= 33.5 ± 2 %
D and E	= 117.0 ± 2 %
F and G	= 108.0 ± 2 %
H and I	= 75.0 ± 2 %
J	= 92.0± 2 %

Note 1—If headform is found to be symmetrical or is to be made symmetrical then B = C, D = E, F = G, and H = I.

A = Interpupillary distance.
B = Distance of right eye pupil from sagittal plane.
C = Distance of left eye pupil from sagittal plane.
D = Distance of right eye pupil from top of headform.
E = Distance of left eye pupil from top of headform.
F = Distance of top of right ear/headform junction from top of headform.
G = Distance of top of left ear/headform junction from top of headform.
H = Distance from right side of headform to sagittal plane.
I = Distance from left side of headform to sagittal plane.
J = Distance between front of pupil and top of ear/headform junction.

FIG. 1 CSA Adult Male *(continued)*

4.1.3 *Astigmatism*—When tested in accordance with 6.6, the astigmatism shall not exceed 0.25 diopters.

4.1.4 *Power Imbalance*—When tested in accordance with 6.6, the power imbalance in corresponding meridians between the two eyes for straight ahead seeing shall not exceed 0.18 diopters.

4.1.5 *Prism*—When tested in accordance with 6.4 or 6.8, the primary viewing position of either eye of a shield shall not exceed 0.5 prism diopters.

4.1.6 *Prism Imbalance*—When tested in accordance with 6.4 or 6.8, the prism imbalance shall meet the following criteria:

4.1.6.1 *Vertical Imbalance*, shall not exceed +0.25 diopters.

4.1.6.2 *Horizontal Imbalances*—Negative values (base-in) shall not be less than −0.25 prism diopters, and positive values (base-out) shall not be more than +1.0 prism diopters.

4.1.7 *Luminous Transmittance*—When tested in accordance with 6.3, the luminous transmittance shall not be less than 60 % for clear lenses and not less than 20 % for tinted lenses, unless labeled **very dark** in which case the minimum transmittance shall be no less than 8 %. All tinted lenses shall be labeled **Not for use in low light conditions** .

4.1.8 *Haze*—When tested in accordance with 6.5, the haze of the EPD shall not exceed 3 %.

4.1.9 *Optical Quality*—Within the central viewing zone, striae, warpage, surface ripples, or other defects that are apparent under the optical inspection test conditions of 6.2 shall be considered a failure. An exception is when small specks or inclusions, which are not seen when the lens is held close to the eye in the as-worn position, shall not be a cause of rejection.

4.1.10 *Physical Lens Defects*—Within the central viewing zone, pits, scratches, grayness, bubbles, cracks, water marks, or other defects that are apparent under the visible inspection test conditions of 6.7 shall be considered a failure. An exception that small specks or inclusions, which are not seen when the lens is held close to the eye in the as-worn position, shall not be cause of rejection.

4.2 *Mechanical Requirements*:

4.2.1 No contact by components of the EPD or paintball fragments with the orbital area of the headform shall be permitted when tested in accordance with Section 7.

4.2.2 Any visible fracture of the lens or frame constitutes a failure.

4.2.3 Any dislodging of the lens from the frame constitutes a failure.

4.2.4 Any dislodging of a lens retention component from the lens constitutes a failure.

4.2.5 Any dislodging of an EPD from the face protection component to which it is attached constitutes a failure.

4.2.6 Any rotation of the headgear system in the headform that would permit contact of a 15.9-mm (0.625-in.) diameter cylindrical probe to the orbital area of the headform constitutes failure.

5. Sample Preparation

5.1 *Eye Protective Devices*:

5.1.1 Only new and complete EPDs as offered for sale shall be tested.

5.1.2 EPDs shall be subjected to a single impact test.

5.1.3 The EPD shall be conditioned for a minimum of 4 h at the specified temperature prior to each test.

5.2 *Test Temperatures*:

5.2.1 *Cold Test*, −12.2°C± 2°C (10°F ± 3.5°F).

5.2.2 *Room Temp*, 23°C± 2°C (73°F ± 3.5°F).

5.2.3 *Hot Test*, 37.8°C± 2°C (100°F ± 3.5°F).

5.3 *Paintballs*:

5.3.1 All impact testing shall be done using paintballs manufactured within the previous eight months. Paintballs shall be used for impact testing only after a sampling of paintballs taken from the bulk container fall within the parameters specified in 5.3.3 and 5.3.4. The paintball bulk container shall be resealed immediately after each group of paintballs is removed. Paintball storage and nontest handling shall be done at a relative humidity below 55 % and at a temperature between 12.7°C (55°F) and 29°C (85°F).

5.3.2 Paintballs used for impact testing shall be conditioned in a sealed packet (bag) for at least 4 h at the specified temperature for each test. Impact testing shall be completed within 3 min after removal of the paintballs from their temperature conditioning atmosphere.

5.3.3 *Weight and Dimension Test*—Measure a sampling of 25 paintballs. Their weight shall be at or between 3.1 and 3.3 g. Their diameter, measured both at the seam and polar, shall be at or between 16.89 and 17.78 mm (0.665 and 0.700 in.).

5.3.4 *Burst Strength Test*—Drop 100 paintballs, individually, from a height of ~~1.33 mm~~ 1.83 m (6 ft) onto a clean concrete floor. At least three but no more than 25 of the 100 paintballs shall break. Discard the unbroken paintballs.

TEST METHODS

6. Optical Test Methods

6.1 *Field of View (Angle of Vision)* :

6.1.1 *Purpose*—This test method is intended to determine the relative unobstructed angle visually available to the user. With the EPD mounted on the standard headform, the pole of the cornea shall be visible to an observer when sighted from the required field angles in accordance with 4.1.1. Any sighting method may be used. Paragraphs 6.1.2-6.1.4 give one method.

6.1.2 *Apparatus*—The concept is to mount ~~an Alderson or~~ a CSA headform, size specified by the manufacturer or chosen by the test lab, in a gimbal. Any gimbal that is sufficiently large and sturdy and properly inscribed with horizontal and vertical protractor markings is acceptable. Figs. 2-4 show front and side vertical schematic views of a wooden gimbal that can be constructed with simple tools. Item A is the base and support for horizontal rotation. A protractor should be marked on the base with its center coincident with the axis of rotation. Base A should protrude forward to allow for the protractor markings. These indicate the position of B. Item B comprises the main carriage of the gimbal. Item C comprises the vertically rotating member. Sections CR and CL are the right and left vertical supports. Fig. 3 shows the horizontal view. A window in the left of the vertical B support makes the protractor markings on section CL visible for accurate setting. Section CL can be pie-shaped, providing that a 60° angle can be read. The markings should be made every 5° and marked every ten. A set screw should be threaded into the B section or a ¼-20 nut can be inlayed if section B is wooden. Ensure that ¼-20 thumb screws are available readily for use as the set screw. The location of the standard head should be planned to obtain a good balance for vertical rotations. The horizontal rotation axis should be in the plane of the corneas. The axis themselves can be 12-mm (½-in.) dowels or 6-mm (¼-in.) metal rods. Fig. 4 shows the location of the pivots for their respective rotations. Fig. 5 shows an example of a test setup. The total path from gimbal to the eye, camera, or light source should be at least 7.31 m (24 ft). Using a mirror facilitates adjusting the gimbal while observing the position of the corneas in the protector. A low power telescope or simply a monocular eye locating ring or washer can be substituted for the video camera. The corneas should be painted white or covered with white or reflecting tape in the form

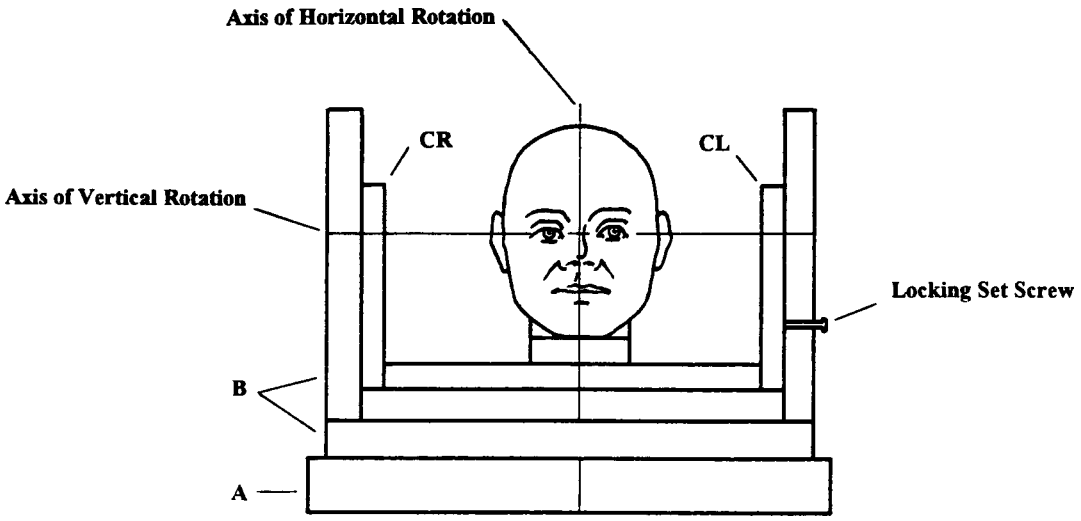


FIG. 2 Schematic of Gimbal for Supporting Standard Head

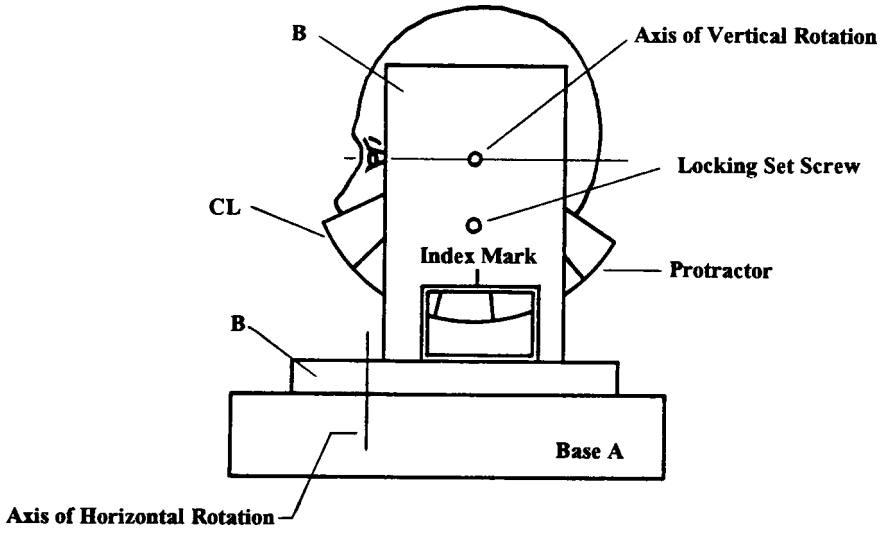


FIG. 3 Side View of Gimbal

of an 8-mm disk. A high level ambient light is desirable. Visual optics may be replaced with photo detectors in the corneas having separate readout means for the two eyes. A strong light source would replace the video camera in which case a low level of ambient light is desirable. A collimating lens would increase the signal to noise ratio of the photo-detectors. The set up as indicated in the drawing introduces a horizontal angle of error of −0.2° and a vertical angle of error of approximately −0.6° at 60°. The location of the vertical angle of tip is centered in the headform to help balance the gimbal. These errors can be accounted for in the decision process. A longer path between the input and output devices will decrease the errors proportionately.

6.1.3 *Test Procedure*—Mount the EPD to be tested on the headform in the intended wearing position. Set the gimbal in the straight ahead position and verify the visibility of metered response of the two eyes. The gimbal then is rotated to determine the horizontal and vertical extreme angles of view in all four directions along which the appropriate corneas can be seen monocularly.

6.1.4 *Report*—Record and report the maximum angles of view in all four directions.

6.2 *Optical Quality*—Localized power errors or aberrations that are detected by the visual inspection procedure of 6.2.1 are permissible if no measureable or gross focimeter or telescope target distortion or blur is found when the localized area is examined with an instrument as indicated in 6.2.2.

6.2.1 *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 45 by 45 cm (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 6 mm [¼ in.] wide). The target should be at least 1.8 to 2.5 m (6 to 8 ft) from the observer, and the lens should be held at least 45 to 60 cm (18 to 24 in.) from the eye. Any ripples in the lens detected by this test method should be further examined in accordance with 6.2.2.

6.2.2 The referee method of detecting optical defects and local aberrations is to scan the central viewing zone, especially areas of suspicion arising form the visual test of 6.2.1. The lens of shield should be scanned with a precision focimeter or an 8× to 10×

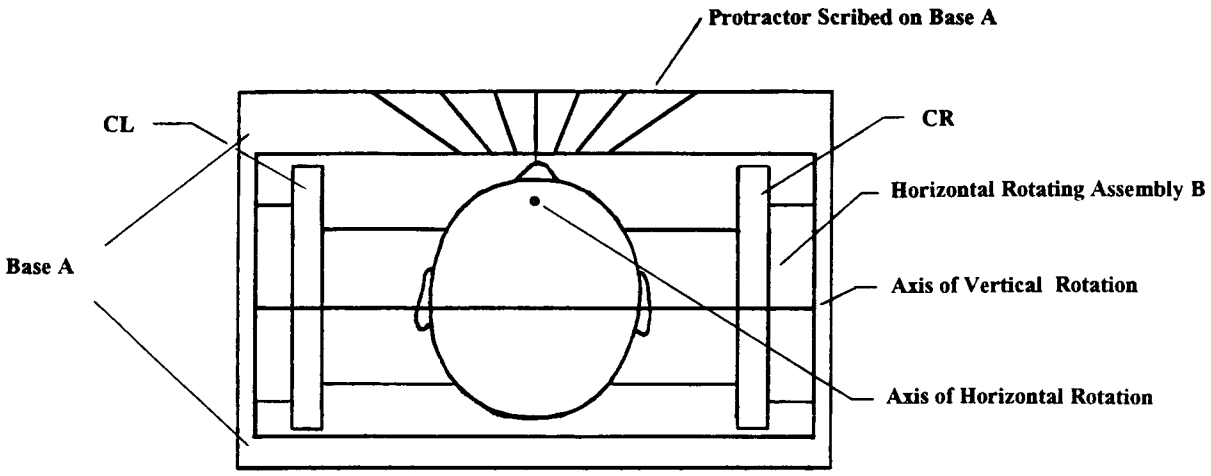


FIG. 4 Top View Showing Base for Horizontal Rotation

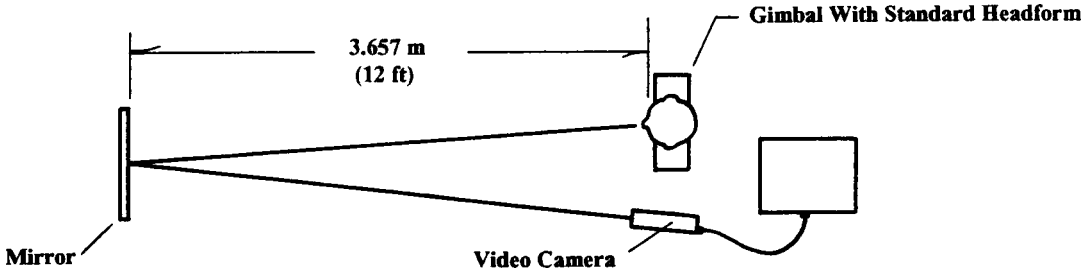


FIG. 5 Bench-Top Field-of-View Setup

telescope using the targets and arrangements described in 6.6.2-6.6.3.2. 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.

6.3 *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 from 1 to 100 %. Use a suitable enclosure to block against stray light and contain the test samples. Following the manufacturers instruction 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, also may be used.

6.3.1 For the purposes of this specification, luminance transmittance may be measured with inexpensive photometers. 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.

6.4 *Prismatic Deviation Measurements* :

6.4.1 *Purpose*—This test is intended to measure the angular deviation of light rays created by the EPD as they pass through the lens(es).

6.4.2 *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 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 target 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 (−).

6.4.3 *Test Procedure*—The normal wearing position can be defined as the line of sight through the lenses, which is parallel with the temples when the lenses are held in a normal expected wearing position. Mount the lenses on a fixture such that the right and left eye positions for the testing line of sight are 64 mm apart. One such device is a board with four dowel sticks inserted so that

the device can be supported in front of the telescope on a suitable bench or table. A single telescope can be used for straight ahead monocular readings. The fixturing device, for example the block of wood, can be slotted to move 64 mm transversely to easily measure the prism and prism imbalance. The telescope should be focused on the target at 4 m and be aligned carefully with the cross hairs on the zero position of the target. A two meridian screw-adjusted support will help. The readings for the right and left eyes must be recorded by using the graph paper target. The monocular prism test is achieved by noting whether the cross hairs remain in the 20-mm radius 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.

6.4.3.1 *Alternate Prism Tests (see 6.8.1)*—Table-top systems with a 1-m sample-to-target distance also are acceptable. The target dimensions should be ¼ of those given in 6.4.2.

6.5 *Haze*:

6.5.1 Measure the EPD for percent haze within the central viewing zones, with the EPD rotated so that the passing beam of light is as perpendicular to the testing surface as is practical, in accordance with the requirements of Federal Test Methods Standards No. 406 and No. 3022. The measured values shall meet the established criteria for the device.

6.5.2 Haze also may be determined with a commercially available Gardner Hazemeter.

6.6 *Refractive Power Measurements* :

6.6.1 *Purpose*—This test method is intended to measure spherical and cylindrical refractive power induced by the EPD.

6.6.2 *Apparatus*—An 8-power telescope with an effective aperture of 19 mm shall be used in conjunction with an illuminated target located a distance of 10.67 m from the telescope objective. The focus adjustment of the telescope shall be calibrated in at least 0.01 diopter increments. The test target shall be that specified by ANSI Z87.1.

6.6.3 *Test Procedure*:

6.6.3.1 Adjust the telescope by setting the calibrated focus adjustment to zero power, then adjust the eyepiece so that the tests target is resolved clearly without the EPD in front of the telescope. The quality of the telescope and the observer's vision should be such that Pattern 40 of the High Contrast Test Chart.[7] is clearly resolved.

6.6.3.2 Mount the EPD in front of the telescope such that the telescope axis passes through either one of the central viewing zones. The angular orientation of the EPD should be the same as used for prismatic deviation measurements. Take refractive power measurements for both central viewing zones.

6.6.3.3 Focus the telescope in the radial lines of the test target until they appear as sharp as possible. Two possibilities may occur.

6.6.3.4 If all radial lines appear equally well focused (sharp) at the same telescope power setting, the EPD has no measurable astigmatism and the power reading of the telescope at that position is the spherical refractive power of the EPD lens.

6.6.4 Measure the maximum meridional power for each eye, recording the extremes, the most plus readings, and the most negative readings. There will be four readings. If any are more plus than 0.06 or more minus than 0.37 diopter, the power test fails. Also, if any of the readings are more than 0.25 diopters apart, the EPD is failed for either astigmatism or power imbalance. If the widely spaced errors are on one side of the lens, it is astigmatism.

6.6.5 Alternate methods of measuring refractive power and astigmatism, such as focimeters, visual, and electronic, may be used. Custom optical bench systems are acceptable provided it can be demonstrated that the precision and bias are at least equivalent to the telescope method described in 6.6.3.

6.7 *Surface Imperfections and Internal Defects*:

6.7.1 Inspect lenses in a lighted room without the aid of magnifying devices.

6.7.2 View lenses against a dark background in the light from an open-shaded 40 W incandescent clear lamp with the lens positioned approximately 305 mm (12 in.) from the light source.

6.7.3 *Visual Function Impairment*—Impairment of the function of the lens may be determined by testing the lens in the "as worn" position before a trained inspector's eye. Impairment is present if the defects against either light or dark plain backgrounds, with side illumination on the lens for the dark background test.

6.8 *Alternate Optical Tests*:

6.8.1 *Alternative Prism Tests*:

6.8.1.1 The target of 6.2.1 (1-cm graph paper subdivided into at least 5-mm squares) is modified as follows: Mark a center point with a black dot not over 1.5 mm in diameter. For a total prism tolerance of 0.50 prism diopters, draw a circle with a 20-mm radius about this center. For vertical prism imbalance tests draw horizontal lines 1 cm above and below center. For a base-in tolerance, draw a vertical line 10 mm to the left of center and for base-out tolerance draw a line 40 mm to the right of center. This target is for use with mirrors and a beam splitter so that both eyes are tested simultaneously. The target for the left eye will be best seen if on black matte paper. The center *X* can be marked with a red pen. The 20-mm radius circle also should be red. No other lines are necessary.

6.8.1.2 The two targets should be mounted laterally and separated by 64 mm. The left eye target should be mounted on a wooden block or cardboard box so that it is 64 mm closer to the telescope than the right eye target. The set up (see Fig. 6) requires a beam splitter and a 45° mirror between the telescope and the test sample. The mirror and beam splitter must be adjusted carefully and the telescope focused carefully for the 4-m distance. Optical bench equipment will facilitate the adjustments. Thin metal shims on the back of the mirror will help. When adjusted properly, the black and red centers, as well as the circles, should be superimposed and the cross hairs of the telescope should be on both centers at the same time.

6.8.1.3 To test a sample, mount it in between the telescope and the beam splitter so that the right eye line-of-sight goes through the beam splitter and the left eye line-of-sight goes through the mirror. The cross hairs should lie within both circles. If they do not, then one or both eyes have more than 0.5 prism diopters.

6.8.1.4 For prism imbalance, the red dot of the left eye should lie in the rectangle marked out for the right eye. If it does not, then there is excess prism imbalance.

7. Mechanical Tests

7.1 *Test Equipment:*

7.1.1 The propelling device shall be capable of hurling the paintballs horizontally as follows: high velocity, 122 ± 6 m/s (400 ± 20 ft/s), repeatable once per second three times in succession; normal velocity, 94.5 ± 6 m/s (310 ± 20 ft/s). Each impact velocity shall be measured and if not within the tolerance, that impact is not valid.

7.1.1.1 If a failure occurs on an EPD due to a shot that was out of the speed range of the paint ball or the shot location was incorrect, the test will be halted at that point and repeated on a new sample.

7.1.2 Impact testing will be performed at the temperatures specified in 7.2.3.2 and, testing shall be completed within 3 min after removal of the EPD from the temperature conditioning atmosphere.

7.1.3 Projectiles shall be paintballs and shall be tested as specified in 5.3.3 and 5.3.4.

7.1.4 Equipment employed to measure the speed of the test paintball within 1.5 m of impact shall be accurate to within ± 0.5 m/s muzzle velocity.

7.1.5 The test headform shall be ~~either an Alderson 50th percentile (eyelid abraded off to provide smooth curvature of the eyeball) or~~ a CSA adult headform size specified by the manufacturer or chosen by the test lab..

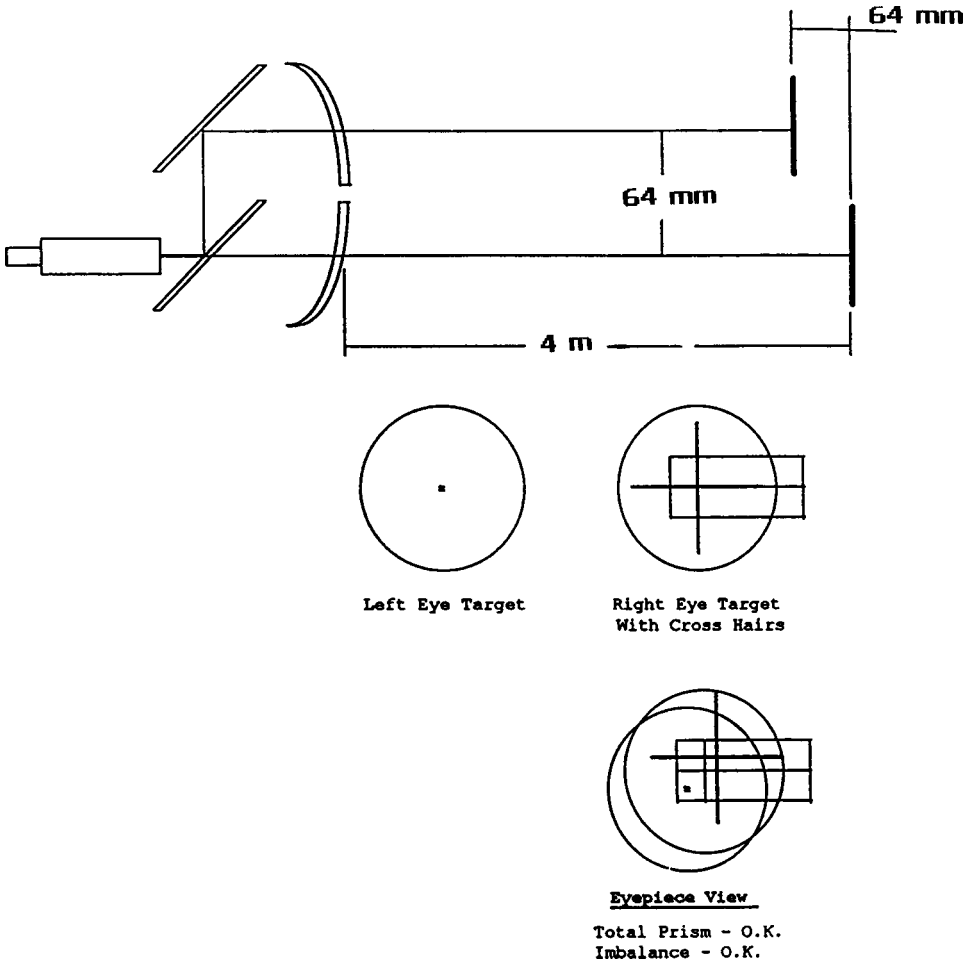


FIG. 6 Alternate Prism Test Set-Up (See 6.8.1)

7.1.6 The test headform should be placed in an enclosed area during impact testing to contain paint spray and paintball fragments.

7.2 *Projectile Test Procedure*:

7.2.1 Apply a fresh pressure sensitive marking device, such as a thin layer of pressure sensitive paste, to the orbital area of the test headform before each series of impacts.

7.2.2 Mount the EPD to be tested on the headform and secure in accordance with the manufacturers instructions.

7.2.3 *High Velocity Impact Test*:

7.2.3.1 *Sample Size*, one EPD (eight impacts).

7.2.3.2 *Test Temperature*, room temperature, condition the EPD at the temperature specified in 5.2.2.

7.2.3.3 Each impact shall be made at an angle perpendicular to the lens surface. Impact the right side of the lens at a point overlying the pupil of the right eye of the headform three times at approximately 2-s intervals at 122 ± 6 m/s (400 ± 20 ft/s). Repeat this impact on the left side of the lens within one minute. Then choose two additional locations on each lens at points where the EPD appears most likely to fail. Impact once at each point.

7.2.3.4 Remove the EPD from the headform and remove paint by rinsing with tap water. Examine the EPD for evidence of failure as defined in 4.2.2, 4.2.3, and 4.2.4.

7.2.4 *Lens Retention Test*:

7.2.4.1 *Sample Size*, three EPDs (eight impacts each).

7.2.4.2 *Test Temperatures*, cold, room temperature, and hot. Condition one EPD at each of the temperatures specified in 5.2.1-5.2.3.

7.2.4.3 Each impact shall be made at 94.5 ± 6 m/s (310 ± 20 ft/s) at an angle perpendicular to the lens surface and at the junction of the lens and the frame. Select locations around the perimeter of the lens where the product appears most likely to fail. Impact the lens in four locations, two times at each location, at approximately 10 s intervals. Choose at least one location at the frame superior, the frame inferior, and the frame temporal as follows:

Frame Superior— Impact at location where lens and frame meet at the top edge of the EPD.

Frame Inferior— Impact at location where lens and frame meet at bottom of EPD.

Frame Temporal— Impact at location where lens and frame meet on side of EPD in line with temple of headform.

7.2.4.4 Remove the EPD from the headform and remove paint by rinsing with tap water. Examine the EPD for evidence of failure as defined in 4.2.2, 4.2.3, and 4.2.4.

7.2.4.5 Evaluation of the EPD (Pass/Fail) in 7.2.3 and 7.2.4 is performed after eight successful impacts are completed.

7.2.5 *Shell Fragment Test*:

7.2.5.1 *Sample Size*, six EPDs (one impact each).

7.2.5.2 *Test Temperatures*, cold, room, and hot, as specified in 5.2 (Two protectors impacted at each temperature).

7.2.5.3 Each impact shall be made at 94.5 ± 6 m/s (310 ± 20 ft/s) at an angle normal to the lens surface and at the junction of the lens and frame. Select locations around the perimeter of the lens where the product appears most likely to fail, each protector being impacted one time, providing for two impacts at each temperature.

7.2.5.4 After each impact, remove the protector from the headform carefully so as not to impart any paint from the protector's outer surface to the headform. Examine the headform for evidence of failure as defined in 4.2.1.

7.3 *EPD System Retention Test*:

7.3.1 *Sample Size*, one EPD (three impacts).

7.3.2 *Test Temperature*, room temperature, as specified in 5.2.2.

7.3.3 Each impact shall be made at 94.5 ± 6 m/s (310 ± 20 ft/s) in the horizontal corneal plane at an angle of 110° from the normal incident axis. Each impact shall be made at the same point that is on the side surface of the EPD, midway between the posterior edge of the lens and the posterior border of the EPD in the horizontal corneal plane. In the event that the EPT shifts, the headform shall be adjusted so that the second and third impacts are made at the original impact location.

8. General Requirements

8.1 *Materials of Construction*:

8.1.1 Materials exposed to sunlight shall not undergo significant loss of physical properties.

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

8.1.3 Materials coming into contact with the wearer's face 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.

8.1.3.1 Manufacturer will provide material selection and, by affidavit, support sections 8.1.1-8.1.3.

8.2 *Openings*—All openings in the EPD, such as those for ventilation, shall be designed in a manner that prevents direct impacts by paintball fragments to the eyes.

9. Product Marking

9.1 Each EPD frame and each lens shall bear the following permanent marking:

9.1.1 Manufacturer's identity.

9.1.2 Month and year of manufacture.

9.2 A label or tag bearing the following information shall be attached to, or shall accompany the EPD, at the time it leaves the manufacturer:

9.2.1 Warning that failure to follow all these instructions or adhere, or both, to all these warnings may result in serious or permanent injury.

9.2.2 Warning never to remove the EPD while on the playing field.

9.2.3 Warning to wear the EPD whenever shooting a paintgun and whenever in or near an area where paintball guns are being shot.

9.2.4 Warning that all paintball guns must be chronographed and not to play where paintball velocities exceed 300 fps. Warning to observe at all times the rules of safe play and the rules of safe paintgun handling.

9.2.5 Warning to wear ear and face protection if they are not integral parts of the EPD. Warning that the goggle strap is not an ear protector.

9.2.6 Warning to check the lens before and after use and to replace the lens immediately if any cracks are observed anywhere in the lens. Warning to replace the lens immediately if the lens is subjected to a direct impact form a paintball from a distance under 10 ft.

9.2.7 Warning to replace the lens after it has been in use for one year.

9.2.8 Warning, for an EPD without anti-fog treatment, that fogging may occur, and recommend the application of an anti-fog solution.

9.2.9 Instructions on what anti-fog substances(s) may be used on the lens. Warning not to use other substance(s) on the lens.

9.2.10 Instructions on how to remove and install a lens.

9.2.11 Warning to use only lenses designed to fit the specific EPD model.

9.2.12 Instructions on how to attach accessories, such as facemask, ear protectors, etc.

9.2.13 Instructions on how to store the EPD.

9.2.14 Instructions on how to fit the EPD on the head properly for various head sizes.

9.2.15 Instructions on when and how to clean the EPD.

10. Keywords

10.1 EPD; eye protective devices; eye protectors; goggles; paintball; paintball sports

APPENDIXES

(Nonmandatory Information)

X1. SUGGESTED DATA REPORT FORMAT

X1.1 The following information should be included in a test report of tests performed in accordance with this specification:

X1.1.1 Person(s) performing tests and person(s) approving report, with dates.

X1.1.2 Source, description, and numbering of the test specimens.

X1.1.3 Temperature and humidity data should be recorded on data sheets and included in the report as required by this specification.

X1.1.4 Test procedure with appropriate reference to the paragraphs of this specification.

X1.1.5 Description of test equipment with calibration dates and frequency.

X1.1.6 Summary of the data with indications of compliance with the requirements of this specification.

X2. RECOMMENDED METHOD FOR SECURING EPD TO HEADFORM

X2.1 If instructions for securing EPD are not provided, the following method will be used in section 7.2.2– mounting eye protector: Tighten bands or straps (if provided) in such a manner that a force of 3 lbf provides no less than a 1 in. space between the headform and the strap of the EPD, when a device similar to that indicated in Fig. X2.1 is inserted under the strap of the EPD at the center back of the headform.

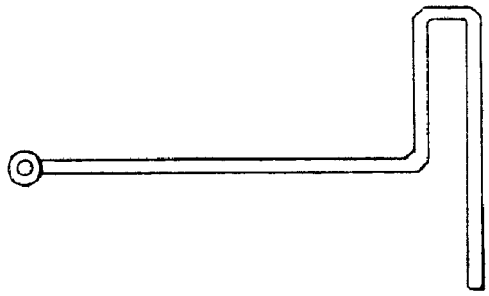


FIG. X2.1