
**Eye and face protection — Test
methods —**

**Part 1:
Geometrical optical properties**

*Protection des yeux et du visage — Méthodes d'essai —
Partie 1: Propriétés optiques géométriques*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 6, *Eye and face protection*.

This first edition of ISO 18526-1, together with ISO 18526-2, cancels and replaces ISO 4854:1981 which has been technically revised.

A list of all parts in the ISO 18526 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The family of documents comprised of the ISO 16321 series, the ISO 18526 series and the ISO 18527 series was developed in response to the worldwide stakeholders' demand for minimum requirements and test methods for eye and face protectors traded internationally. ISO 4007 gives the terms and definitions for all the various product types. The test methods are given in the ISO 18526 series, while the requirements for occupational eye and face protectors are given in the ISO 16321 series. Eye protectors for specific sports are mostly dealt with by the ISO 18527 series. A guidance document, ISO 19734, for the selection, use and maintenance of eye and face protectors is under preparation.

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Eye and face protection — Test methods —

Part 1: Geometrical optical properties

1 Scope

This document specifies the reference test methods for determining the spherical, cylindrical, and prismatic refractive power properties of unmounted and mounted plano lenses (non-corrective lenses) for eye and face protectors.

This document does not apply to any eye and face protection product requirement standards for which other test methods are specified.

Other test methods can be used provided they have been shown to be equivalent and include uncertainties of measurement no greater than those required by the reference method.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 4007, *Personal protective equipment — Eye and face protection — Vocabulary*

ISO 18526-4:2020, *Eye and face protection — Test methods — Part 4: Headforms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4007 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Preparatory information

Before testing, refer to the appropriate product's requirements standard for the information needed to apply the tests in this document, for example:

- the number of test samples¹⁾;
- preparation of test samples;
- the selection of test samples (if included in this document);

1) For the purpose of this document, "test sample" is taken to be the object under test, e.g. "lens", "filter" or "complete protector" as specified in the requirement standards.

- any prior conditioning or testing;
- test method (if more than one are included in this document);
- any deviations from the method(s);
- characteristics to be assessed subjectively (if appropriate);
- pass/fail criteria.

5 General test requirements

Unless otherwise specified, the values stated in this document are expressed as nominal values. Except for temperature limits, values that are not stated as maxima or minima shall be subject to a tolerance of $\pm 5\%$.

Unless otherwise specified, the ambient temperature for testing should be between $16\text{ }^{\circ}\text{C}$ and $32\text{ }^{\circ}\text{C}$ but if any temperature limits are specified, these should be subject to an accuracy of $\pm 2\text{ }^{\circ}\text{C}$. Relative humidity should be maintained at $(50 \pm 20)\%$.

Unless otherwise specified, the test samples shall be tested at the reference points (for testing) as defined in ISO 4007.

The tests shall be done by trained observers.

For each of the required measurements performed in accordance with this document, a corresponding estimate of the uncertainty of measurement shall be evaluated according to [Annex A](#).

6 Geometrical optical test methods

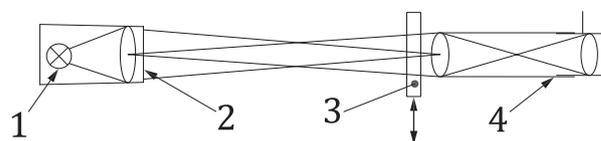
6.1 Test method for refractive power and prismatic power for plano lenses

6.1.1 Principle

This test is intended to measure the refractive power and prismatic power for nominally plano lenses and is called the telescope method.

6.1.2 Apparatus

A schematic drawing of a possible telescope set-up is given in [Figure 1](#). Alternatively, an externally illuminated telescope target may be used.



Key

- 1 light source
- 2 telescope target
- 3 test sample
- 4 telescope

Figure 1 — Schematics of telescope set-up

6.1.2.1 Telescope, with a nominal aperture of 20 mm and a magnification between $\times 10$ and $\times 30$, fitted with an adjustable eyepiece incorporating a reticule. The focusing adjustment shall have a scale of refractive power such that the telescope can be calibrated with a maximum uncertainty of measurement of $0,01 \text{ D}^2$) using the test method described in 6.1.2.4.

6.1.2.2 Illuminated target, consisting of a black plate incorporating the cut-out pattern shown in [Figure 2](#), behind which is a light source of adjustable luminance. A condenser lens may be necessary to achieve sufficient luminance by focusing the light source on the telescope objective.

The large annulus of the target has an outer diameter of $(23,0 \pm 0,1)$ mm with an annular aperture of $(0,6 \pm 0,1)$ mm. The small annulus has an inner diameter of $(11,0 \pm 0,1)$ mm with an annular aperture of $(0,6 \pm 0,1)$ mm. The central aperture has a diameter of $(0,6 \pm 0,1)$ mm. The bars are $(20,0 \pm 0,1)$ mm long and $(2,0 \pm 0,1)$ mm wide with a $(2,0 \pm 0,1)$ mm separation. The distance from the outer circle to the inner bars shall be $(2,0 \pm 0,5)$ mm.

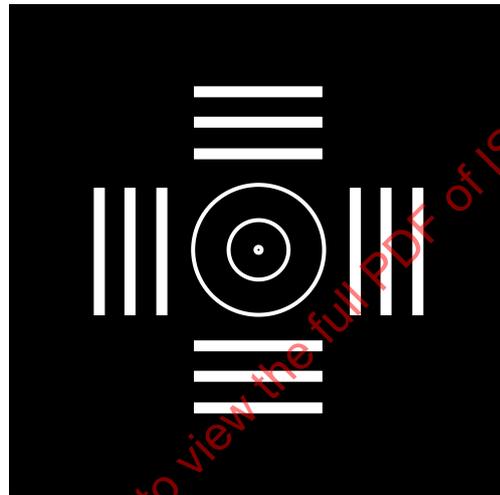


Figure 2 — Telescope target (dimensions are given in [6.1.2.2](#))

6.1.2.3 Filter (optional), with its maximum transmittance in the green part of the spectrum to reduce chromatic aberration. It is recommended that a filter with a spectral transmittance that is similar to the CIE 1931 standard colorimetric observer according to ISO/CIE 11664-1 be used.

6.1.3 Calibration of the apparatus

The apparatus shall be calibrated to achieve an uncertainty of measurement less than or equal to $0,01 \text{ D}$. This can be accomplished by using the method of adjusting the distance between the target and telescope according to [Annex B](#) or by using calibrated reference lenses e.g. these lenses shall have nominal positive and negative spherical powers of $0,06 \text{ D}$, $0,12 \text{ D}$ and $0,25 \text{ D}$.

NOTE To achieve the $0,01 \text{ D}$ uncertainty of measurement, the calibration of the reference calibration lenses needs to have an uncertainty of measurement less than $\pm 0,008 \text{ D}$.

6.1.4 Procedure

6.1.4.1 General

The telescope and illuminated target are placed on the same optical axis $(4,60 \pm 0,02) \text{ m}$ apart.

2) D is a commonly used symbol for the unit of focal power, the dioptre. This has dimensions of m^{-1} which is used in some countries as the official unit.

The test shall be carried out as follows.

- Focus the reticule and the target and align the telescope to obtain a clear image of the pattern. This setting is the zero point of the focusing scale of the telescope.
- Align the telescope so that the central aperture of the target is imaged on the centre of the cross-line reticule. This setting is the zero point of the prism scale position.
- Position the test sample in front of the telescope in the as-worn position. For unmounted lenses, position the lens into the appropriate frame provided by the manufacturer to determine the as-worn position with the specified headform.

Measurements of spherical and cylindrical power shall be taken using the procedures specified in [6.1.4.2](#).

If, during measurement using the telescope, a doubling or other aberration of the image is observed, then the test sample shall be subjected to further examination using the test method described in [6.3](#).

6.1.4.2 Spherical and cylindrical power

The test shall be carried out as follows.

- Rotate the target, or the test sample, in order to align the principal meridians of the test sample with the bars of the target.
- Focus the telescope firstly on one set of bars (measurement F_1) and then on the perpendicular bars (measurement F_2). The spherical power is the mean, $\frac{F_1 + F_2}{2}$, the cylindrical power is the absolute difference, $|F_1 - F_2|$, of the two measurements.

During this process, the best focus for each meridian across the whole target shall be used. An example for a lens with cylindrical power is given in [Figure 3](#).

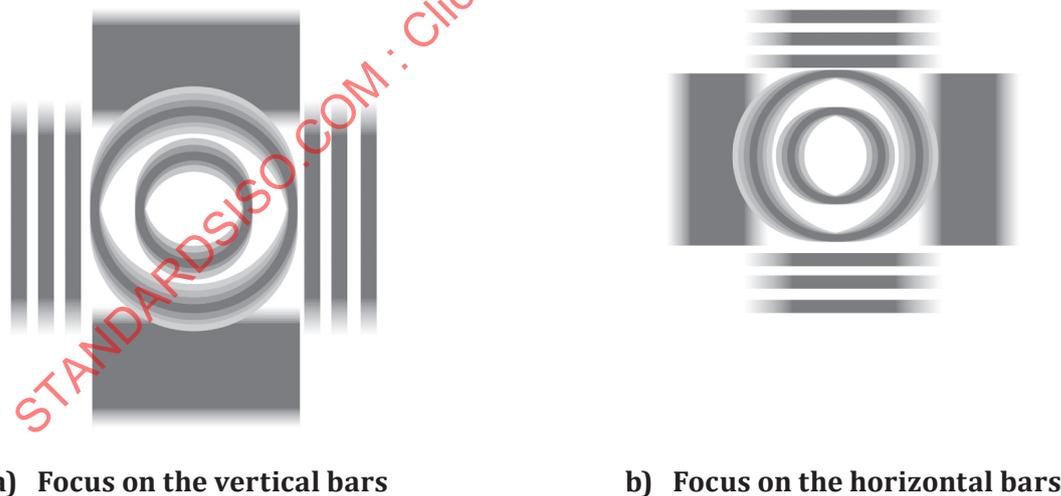


Figure 3 — Image of the target for a lens with cylindrical power

6.1.4.3 Prismatic power for unmounted lenses covering one eye

The test shall be carried out as follows.

- Place the test sample in front of the telescope in the as-worn position.

If the point of intersection of the lines of the reticule fall outside the image of the large circle, the prismatic power exceeds $0,25 \Delta^3$. If the point of intersection of the lines of the reticule falls inside the image of the small circle of the target, the prismatic power is less than $0,12 \Delta$.

6.1.4.4 Test report

The measured values (spherical, cylindrical power and prismatic power) shall be reported.

6.2 Test method for the prism imbalance of complete eye protectors or lenses covering both eyes

6.2.1 Principle

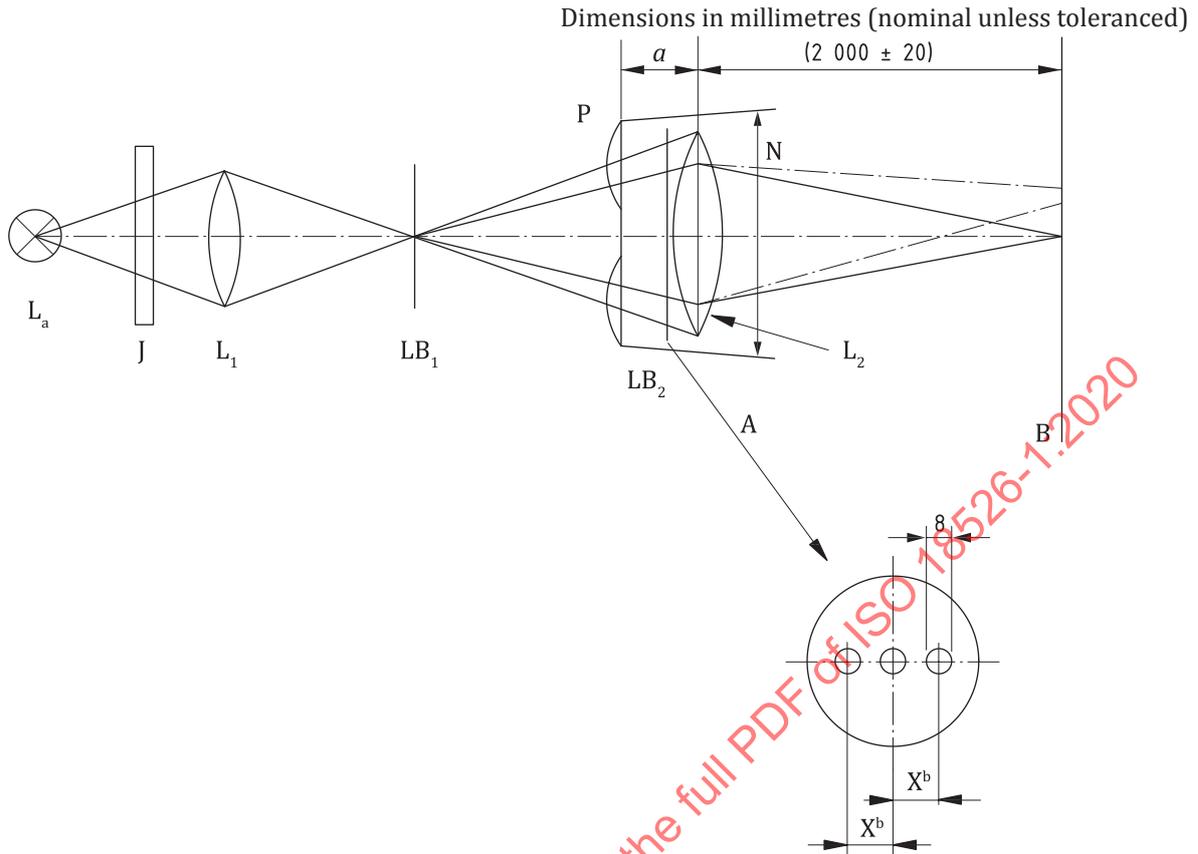
This test method determines the prism imbalance (relative prism error) in the as-worn position at the two reference points of mounted lenses in complete eye protectors, or at the two reference points on the lens if it is designed to cover both eyes.

6.2.2 Apparatus

The arrangement of the test apparatus is shown in [Figure 4](#). The uncertainty for the determination of the prism imbalance is equal to or less than $0,05 \Delta$.

NOTE If other light sources (e.g. laser sources) are used, the test apparatus needs to be adapted accordingly (e.g. expansion of the beam before LB_1 might be necessary).

3) Δ is a commonly used symbol for the unit of prismatic power, the prism dioptre. This has dimensions of cm/m, which is used in some countries as the official unit.



Key

- L_a light source for example, small filament lamp or laser with wavelength of (600 ± 70) nm
- L_1 lens, focal length between 20 mm and 50 mm
- LB_1 diaphragm, diameter of aperture 1 mm nominal
- P test sample
- LB_2 diaphragm as shown in detail A
- L_2 lens, 1 000 mm nominal focal length and 75 mm nominal diameter
- B image plane
- a distance, which should be as small as possible, between the test sample and the lens L_2
- X^b half of the interpupillary distance (PD) defined by the headform specified in ISO 18526-4
- N pinna breadth as defined by the headform specified in ISO 18526-4
- J filter with peak transmittance in the green part of the spectrum (required only if a filament lamp is used as the light source)

Figure 4 — Possible arrangement of apparatus for measurement of prism imbalance (schematic)

6.2.3 Procedure

The diaphragm LB_1 is illuminated by the light source assembly and both are adjusted so that they produce a single, sharp image on the plane B when the test sample P is not in position.

The test shall be carried out as follows.

- Place the test sample in front of the lens L_2 , taking into account the pinna breadth N in [Figure 4](#) in the as-worn position as determined on the specified headform according to ISO 18526-4:2020, Tables 2 or 3. By default, use the headform 1-M.

- Select the appropriate diaphragm LB_2 with X^b being half the interpupillary distance of the appropriate headform according to ISO 18526-4:2020, Tables 2 or 3.
- Measure the vertical and horizontal distances between the two displaced images arising from the two reference points of the test sample.

These distances in centimetres are divided by two to give the horizontal and vertical prism imbalance in cm/m (prism dioptres).

If the light paths (which correspond to the two eye regions) cross, the prismatic refractive power is 'base in' and if the light paths do not cross, it is 'base out'.

6.2.4 Test report

The measured values and direction of the prism imbalance shall be reported.

6.3 Spatial deviations

6.3.1 Principle

This test method is based on the visual distortions resulting from localized variation in the focal and prismatic powers of a lens of the protector being tested caused by irregularities in its surface or refractive index. These irregularities can give spatial disturbance, distortion and binocular disparities that are more pronounced in dynamic visual activities. Spatial deviations are evaluated by the degree and rate of change of distortions of the test grid.

6.3.2 Apparatus

6.3.2.1 Test grid, square with black lines of width $(0,5 \pm 0,1)$ mm spaced $(5,0 \pm 0,5)$ mm apart. The total size of the grid should be paper size A4 (approximately 200 mm × 300 mm). The grid should be on a translucent sheet. An example is given in [Figure 5](#). For better visibility, it is recommended to use backlighting of the test grid.

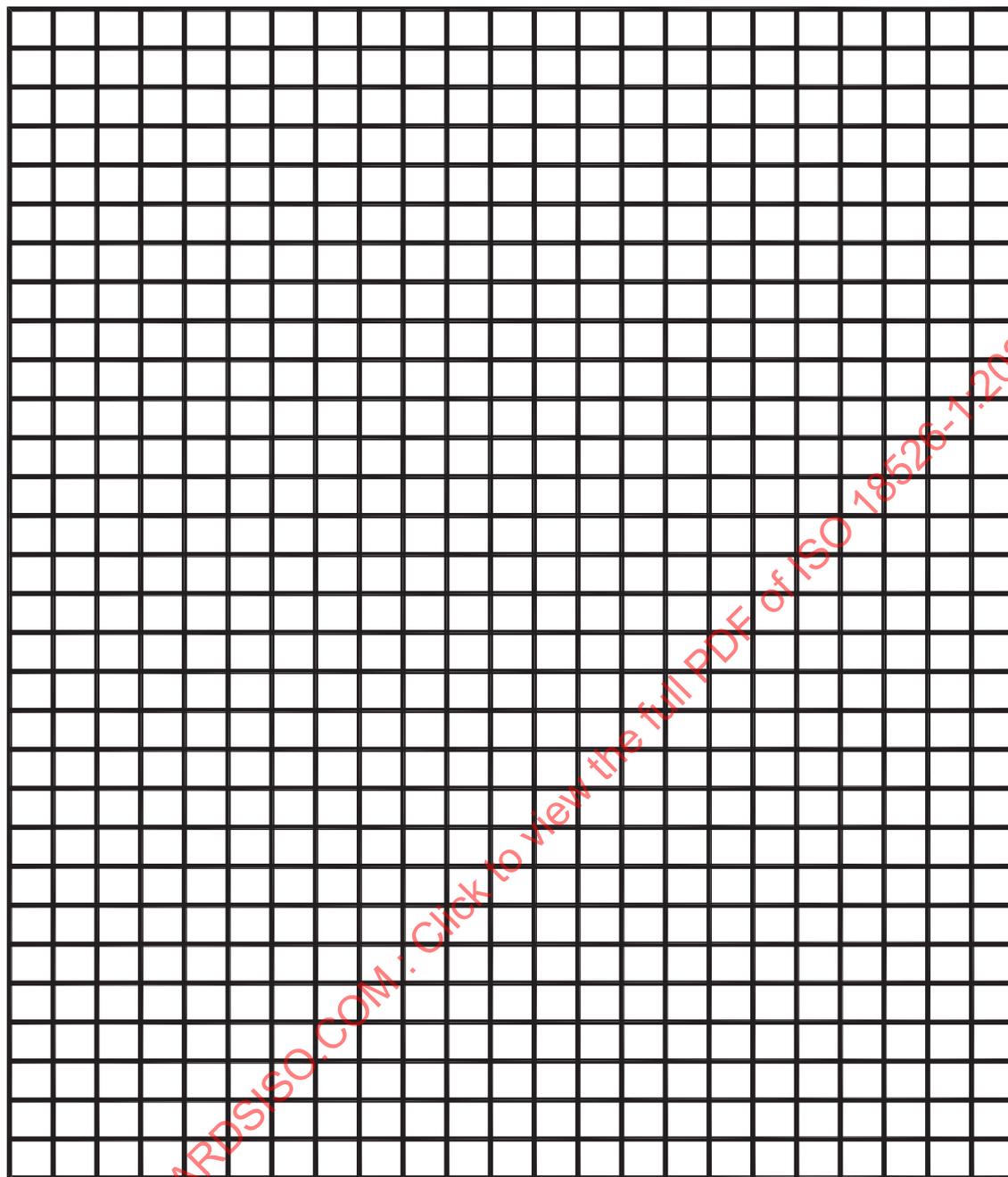


Figure 5 — Portion of the grid

6.3.3 Procedure

The test shall be carried out as follows.

- Hold the lens of the test sample (300_{-25}^0) mm from the dominant eye and while closing the other eye.
- Look through the sample lens of the test sample and focus the eyes on the grid at a distance of (900 ± 50) mm from the eyes, while moving the sample lens of the test sample from side to side.

6.3.4 Test report

Within the area specified in the corresponding product requirement standard around the reference point, the lens of the test sample shall be free from irregular distortion of the grid's image that is likely to impair vision when in use. The result of the test (pass/fail) shall be reported.

7 Uncertainty of measurement

An estimate of the uncertainty of measurement associated with the test methods specified in [6.1](#) and [6.2](#) shall be established, as given in ISO/IEC Guide 98-3. The test methods shall be shown to deliver uncertainties of measurements not exceeding 0,01 D for spherical and cylindrical power and 0,05 Δ for prismatic power and prism imbalance. The application of uncertainty of measurement with regard to the pass/fail criteria shall be as defined in [Annex A](#).

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Annex A (normative)

Application of uncertainty of measurement

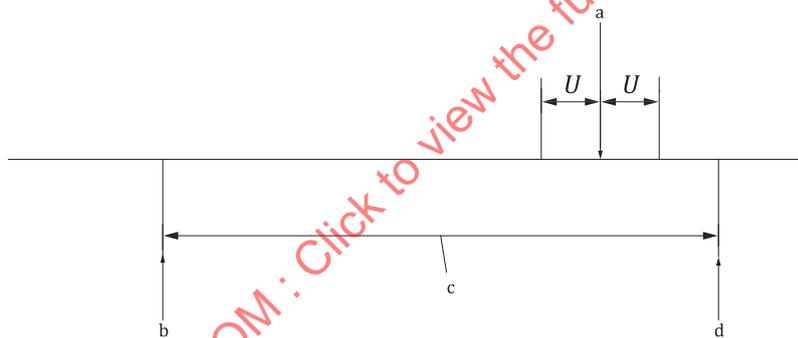
A.1 General

This annex sets out how uncertainty of measurement shall be taken into account when stating compliance.

A.2 Procedure

In order to determine whether the measurement made in accordance with the test methods complies with the specification limit(s) given in eye and face protection product's requirement standards, the following protocol shall be applied.

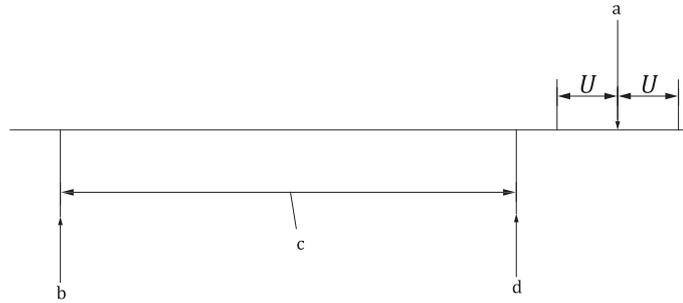
If the measurement (test result), plus or minus the uncertainty of measurement, U , falls completely inside or outside the specification zone for the particular test given in the product's requirement standard, then the result shall be deemed to be a straightforward pass or fail (see [Figures A.1](#) and [A.2](#)).



Key

- U uncertainty of measurement
- a Measured value.
- b Lower specification limit.
- c Specification zone.
- d Upper specification limit.

Figure A.1 — Result "pass"

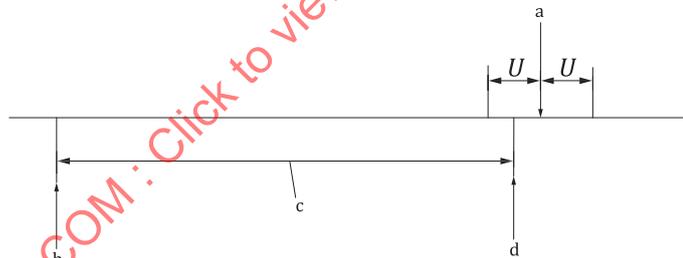
**Key**

- U uncertainty of measurement
- a Measured value.
- b Lower specification limit.
- c Specification zone.
- d Upper specification limit.

Figure A.2 — Result "fail"

If the measurement (test result), plus or minus the uncertainty of measurement, U , overlaps a specification limit value (upper or lower) for the particular test given in the product's requirement standard, then the assessment of pass or fail shall be determined based on the safety for the wearer of the device; this means that the result shall be deemed to be a failure (Figures A.3 and A.4).

NOTE As a consequence of the requirements of this annex, minimizing uncertainty of measurement (smaller values of U) results in increased compliance.

**Key**

- U uncertainty of measurement
- a Measured value.
- b Lower specification limit.
- c Specification zone.
- d Upper specification limit.

Figure A.3 — Result "fail"