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Optics and photonics — Test methods for telescopic systems —

Part 6:
Test methods for veiling glare index

Optique et photonique — Méthodes d'essai pour systèmes télescopiques —

Partie 6: Méthodes d'essai de l'indice de lumière parasite

Reference number
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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 4, *Telescopic systems*.

This second edition cancels and replaces the first edition (ISO 14490-6:2005), of which it constitutes a minor revision. ISO 14490 consists of the following parts, under the general title *Optics and photonics — Test methods for telescopic systems*:

— *Part 1: Test methods for basic characteristics*

— *Part 2: Test methods for binocular systems*

— *Part 3: Test methods for telescopic sights*

— *Part 4: Test methods for astronomical telescopes*

— *Part 5: Test methods for transmittance*

— *Part 6: Test methods for veiling glare index*

— *Part 7: Test methods for limit of resolution*

— *Part 8: Test methods for night-vision devices*

Optics and photonics — Test methods for telescopic systems —

Part 6: Test methods for veiling glare index

1 Scope

This part of ISO 14490 specifies the test methods for the determination of the veiling glare index of telescopic systems and observational telescopic instruments.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9358:1994, *Optics and optical instruments — Veiling glare of image forming systems — Definitions and methods of measurement*

ISO 14132-1, *Optics and photonics — Vocabulary for telescopic systems — Part 1: General terms and alphabetical indexes of terms in* ISO 14132

ISO 14490-1:2005, *Optics and photonics — Test methods for telescopic systems — Part 1: Test methods for basic characteristics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14132-1 apply.

4 General considerations

The veiling glare test methods are generally described in ISO 9358:1994. ISO 9358:1994 deals with arbitrary optical instruments and contains two basic approaches to measuring the veiling glare, namely integral (or black patch) method and analytical (or glare spread function) method.

For terrestrial telescopes with which this part of ISO 14490 deals, the black patch method is more adequate while the glare spread function might prove to be better for astronomical telescopes. For the moment, consideration in this part of ISO 14490 is given only to the black patch method. If need of measuring the glare spread function arises, the reference shall be made directly to appropriate clauses of ISO 9358:1994.

From the classification given in ISO 9358:1994, Clause 3, the case where both the object and the image are at infinity will usually apply to telescopic systems. Clauses 6 and 7 give detailed and more specific descriptions of the general test method given in ISO 9358:1994, 4.1 and of test conditions given in ISO 9358:1994, 5.1.

5 Principle

The determination of the veiling glare index, S, is based upon the measurement of the illuminance of the image of a black surface in diffuse scattered white light and the measurement of the illuminance of the image of the white background.

The veiling glare of an optical instrument is determined by the ratio of the illuminance, E_1, of the image of a black surface within a white illuminated wide surface to the illuminance, E_2, of an image of a totally white surface.

$$S = \frac{E_1}{E_2} \tag{1}$$

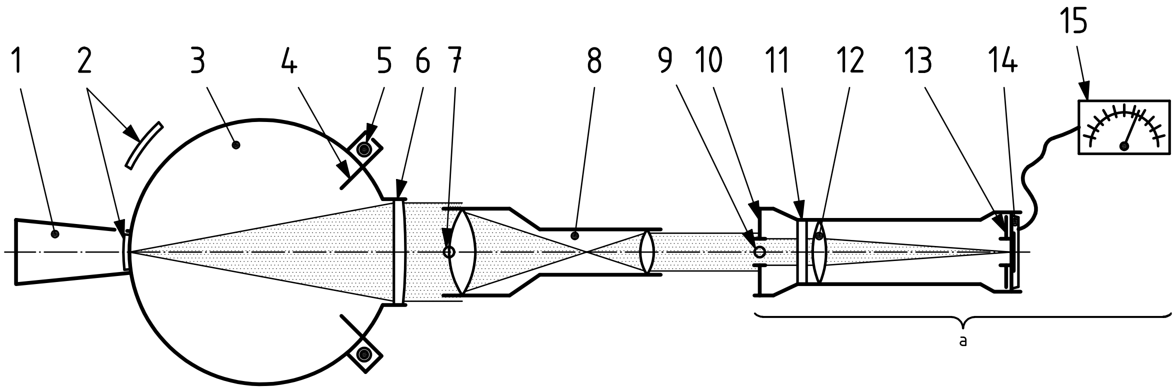
NOTE In both cases, the white surface ensures a homogenous distribution of the illumination across the whole entrance pupil of the test specimen.

6 Test arrangement

6.1 General

The measurement set-up consists of an integrating sphere, an object-side collimator, the test specimen mounting, the limiting stop, the image-side collimator, and the measurement and evaluation unit.

See Figures 1 and 2.

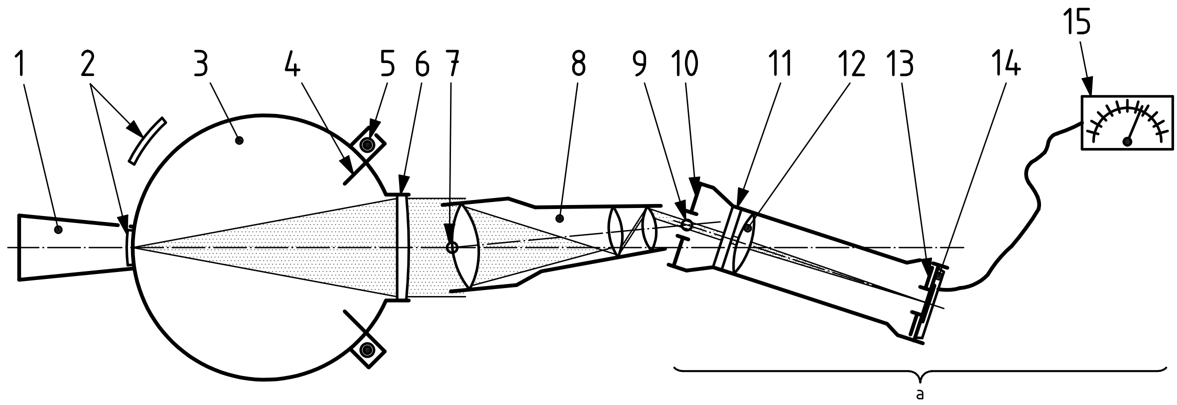


Key

1	black object simulator	6	object-side collimator lens	11	filter
2	selectable segments	7	slewing point I	12	image-side collimator lens
3	integrating sphere	8	test specimen	13	measuring stop
4	baffle	9	slewing point II	14	radiation detector
5	light source	10	limiting stop	15	indicator

a The measurement and evaluation unit consists of the limiting stop, filter, image-side collimator lens, measuring stop, radiation detector, and indicator.

Figure 1 — Test arrangement for on-axis measurement (schematic)



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1	black object simulator	6	object-side collimator lens	11	filter
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3	integrating sphere	8	test specimen	13	measuring stop
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5	light source	10	limiting stop	15	indicator

a The measurement and evaluation unit consists of the limiting stop, filter, image-side collimator lens, measuring stop, radiation detector, and indicator.

Figure 2 — Test arrangement for off-axis measurement (schematic)

6.2 Integrating sphere

The integrating sphere should have a diameter 15 times the diameter of the entrance pupil of the test specimen, but at least 1 m.

It has two opposite openings. In the first opening, the collimating lens is inserted. In the second opening, removable circular elements adapted to the interior surface of the sphere are inserted to act as white and black reference surfaces.

The white reference surface is composed of a disk that entirely fills the second opening in the sphere. The black reference surface is composed of a disk with an aperture of the desired diameter (i.e. an annulus) that is fitted into the second opening in the sphere. It is followed by a light trap outside the sphere. The luminance of the light trap shall be less than 0,1 % of the luminance of the illuminated interior surface of the sphere.

NOTE See Annex A for background information about the black patch method.

The interior surface of the sphere and the annular and circular elements shall be white and opaque. The reflectance across the whole spectral range from 380 nm to 780 nm should be at least 85 %.

The light source shall emit a constant radiant flux. The radiant flux shall not change more than 1 % during the measurement of one pair of values. The light source shall correspond to a black body source with a colour temperature between 2 800 K and 3 200 K.

6.3 Object-side collimator

For the purpose of a collimator, an achromatic lens with a minimum *f*-number of 10 (i.e. maximum relative aperture 1:10) is appropriate, but the aperture shall exceed 1,2 times the diameter of the objective lens of the test specimen.

The focal length of the collimator and the interior diameter of the sphere shall be identical. All glass-air surfaces need an antireflection coating.

The object-side collimator is being fixed in the opening so that the collimator with its frame closes the interior of the sphere and the lens is located outside the sphere.

6.4 Test specimen mounting

The test specimen mounting shall be constructed in a way that the combination of the test specimen and the measurement and evaluation unit can be adjusted and held stable and turned around the entrance pupil for off-axis measurements.

Additionally, the test specimen mounting shall be constructed in a way that the measurement and evaluation unit can be turned around the exit pupil for off-axis measurements.

6.5 Limiting stop

In the plane of the test specimen's exit pupil, a limiting stop of 8 mm diameter shall be attached.

NOTE 1 This limiting stop prevents light which would not reach the observer's eye from entering the radiation detector.

NOTE 2 A limiting stop of 8 mm diameter is assumed to match the eye's maximum pupil diameter.

6.6 Measurement and evaluation unit

The measurement and evaluation unit consists of the limiting stop, the filter, the image-side collimator, the radiation detector, and the indicator.

The image-side collimator (achromatic lens with antireflection coatings) images the white or black reference surface at the surface of the radiation detector.

It shall be positioned directly behind the test specimen's exit pupil. The clear aperture shall be at least 10 mm.

At the image surface in front of the radiation detector, a measuring stop with a diameter of 20 % to 50 % of the diameter of the image of the black surface is arranged.

The filter serves to convert the spectral sensitivity curve of the detector to the photopic response curve of the human eye for the radiation source used.

The size and aperture of the radiation detector shall be sufficient to collect all radiation which is transmitted by the measuring stop.

7 Procedure

7.1 Adjustment of the measurement set-up

Thoroughly clean the optical surfaces of the collimators and of the test specimen.

The size of the black surface corresponds to a 1° object-side field of view; this is valid for test specimens with at least 2° field of view. If the test specimen has a smaller field of view, then the object-side angle of the black surface should correspond to about half the test specimen's field of view.

Attach the test specimen as closely as possible to the object-side collimator and centre it to the optical axis. This ensures that the light enters the test specimen with the maximum solid angle.

7.2 Determination of results

First, measure the illuminance in the image of the white surface, then measure the illuminance in the image of the black surface.

For the determination of the veiling glare index of off-axis object points, slew the test specimen around the entrance pupil and slew the measurement and evaluation unit around the exit pupil.

For the measurement off-axis, object points of 0,5 and 0,7 of half the field of view shall be chosen.

Because the veiling glare index of non-rotationally-symmetric erecting systems (prisms) is not equal at corresponding azimuths, determine the maximum value.

8 Presentation of results

The veiling glare index, *S*, is expressed as a percentage.

The measurement results shall be presented in tabular and in graphical form, as follows.

a) In the presentation in tabular form, the measurements, and the calculated values of the veiling glare index (see Note) shall be given; the values shall be expressed as a percentage to one decimal digit.

b) In the graphical presentation, the values of the veiling glare index shall be plotted over the angles of the field of view.

NOTE The measurement of the veiling glare index depends on the measurement environment, which is determined in detail by the black surface, the diameter of the limiting stop at the test specimen's exit pupil, and the collimating lens.

9 Repeatability

The relative error of the measurement repeatability of the veiling glare index shall not exceed 10 %.

10 Test report

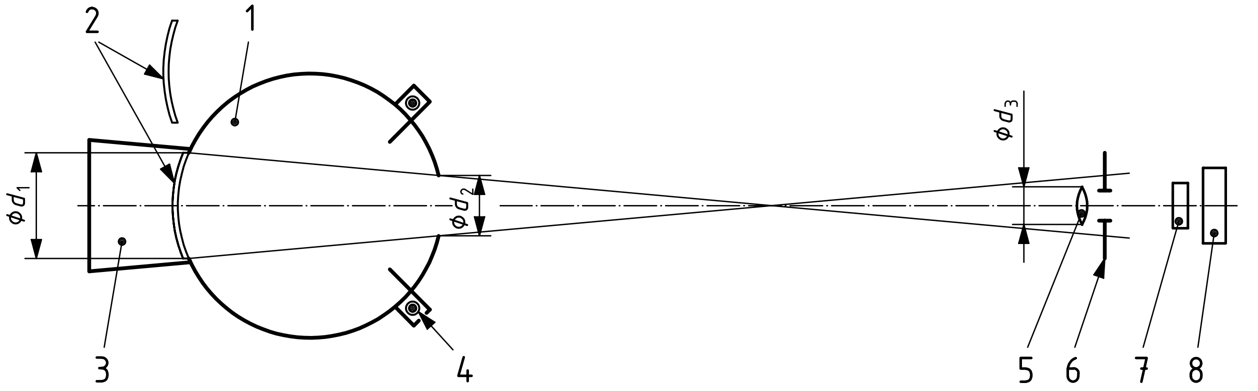
A test report shall be presented and shall include the result of the test as specified in Clause 8 and the general information specified in ISO 14490-1:2005, Clause 13.

Annex A
(informative)

Method for determination of the luminance ratio of the black reference surface to the internal surface of the integrating sphere

A.1 Test equipment

A photoelectric luminance meter comprising an objective, a photodetector, and an indicating device should be installed in front of the integrating sphere (see Figure A.1). A photodetector aperture should be placed in the focal plane of the objective.



Key

1 integrating sphere
2 selectable segments
3 black object simulator
4 light source
5 objective
6 photodetector aperture
7 photodetector
8 indicating device

Figure A.1 — Arrangement for determination of the luminance ratio (schematic)

The diameters d_1 and d_2 of the apertures of the integrating sphere are selected, by means of annular segments, and the position of the luminance meter in relation to the sphere is adjusted so that the condition of the objective being located within the area of complete shade shown in Figure A.1 is fulfilled.

NOTE 1 To fulfil this condition, for practical purposes a value of d_3 being about $d_2/2$ has proven to be a convenient value.

NOTE 2 A diaphragm can be placed in front of the objective (key pointer 5 in Figure A.1) of the luminance meter.

A.2 Measurement of the luminance of the black reference surface and of the internal surface of the integrating sphere

Take the zero reading N_0 from the scale of the indicating device. For this purpose, install an opaque black shield between the integrating sphere and the luminance meter objective so that the entrance aperture of the luminance meter objective is shielded against the direct rays from the sphere.

Install the removable screen containing the aperture to allow the black reference surface to be seen by the detector. Now remove the opaque black shield and take the reading N_1 from the indicating device so that $(N_1 - N_0)$ is proportional to the luminance of the black reference surface. Replace the segment containing the aperture with the segment having the uniform white surface and take the reading N_2

from the indicating device so that ($N_2 - N_0$) is proportional to the luminance of the internal surface of the integrating sphere.

Calculate the ratio of luminance, C, of the black object to that of the internal surface of the photometric sphere using Formula (A.1):

$$C = \frac{N_1 - N_0}{N_2 - N_0} \quad \text{(A.1)}$$

Bibliography

[1] CIE Publication 53-1982, *Methods of characterizing the performance of radiometers and photometers*

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