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Eye and face protection — Protection against laser radiation —

Part 1: Requirements and test methods

Protection des yeux et du visage — Protection contre le rayonnement laser —

Partie 1: Exigences et méthodes d'essai

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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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 85, *Eye protective equipment,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement). The document was developed as a joint project with IEC/TC 76, "Optical radiation safety and laser equipment".

This first edition of ISO 19818-1 cancels and replaces the first edition of ISO 6161:1981, which has been technically revised.

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

This document was developed in response to the worldwide stakeholders' demand for minimum requirements and test methods for laser eye and face protectors traded internationally.

Preparation of this document aimed to draw upon the best aspects of these preceding standards, and offer improvements where appropriate. The document was developed by a Joint Working Group involving experts from ISO/TC 94/SC 6 (Eye and Face Protection) and IEC/TC 76 (Optical Radiation Safety and Laser Equipment), to bring together the two aspects of personal protection and laser safety.

In the general context of eye and face protection ISO 4007 gives the terms and definitions. 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. ISO 19734 is a guidance document for the selection, use and maintenance of eye and face protectors.

A guidance document addressing selection and use of personal eye and face protection against lasers is currently under development and will form a guide to users of protectors described in this document.

NOTE ISO 6161 was published in 1981 but was not widely adopted. The document was four pages in length. No development of that document has taken place since 1981, although comparable regional standards have since been developed (EN 207[5] and EN 208[6] in Europe; ANSI Z136.7[7] in the United States).

Eye and face protection — Protection against laser radiation —

Part 1: Requirements and test methods

1 Scope

This document is applicable to protectors intended to provide protection against accidental exposure to laser radiation within the wavelength range 180 nm to 1 mm. It specifies the requirements, test methods and marking. Protectors intended for adjustment work on lasers are included in the scope of this document and are marked in the same way as other protectors, but selection of appropriate eyewear for a specific application is a choice of the user. Laser protective filters used as viewing windows in laser equipment machinery or incorporated into optical instruments such as operating microscopes and loupes that may be used for deliberate viewing of laser radiation as part of their function are outside the scope of this document.

Laser radiation in the wavelength range below 180 nm is absorbed in air, therefore eye and face protection should not be required.

This document is applicable to devices intended for patient protection during medical laser procedures except for treatment in the periorbital area. Guidance on eye protectors for patients (including those used for periorbital treatment) is given in ISO/TR 22463.

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

ISO 16321-1:2021, *Eye and face protection for occupational use — Part 1: General requirements*

ISO 16321-2:2021, *Eye and face protection for occupational use — Part 2: Additional requirements for protectors used during welding and related techniques*

ISO 18526-1:2020, *Eye and face protection — Test methods — Part 1: Geometrical optical properties*

ISO 18526-2:2020, *Eye and face protection — Test methods — Part 2: Physical optical properties*

ISO 18526-3:2020, *Eye and face protection — Test methods — Part 3: Physical and mechanical properties*

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 and the following 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/

3.1
resistance category
RC
rating for a protector that specifies its ability to withstand a given level of irradiance or radiant exposure without compromise to its protective properties

Note 1 to entry: Laser filters and frames may provide different resistance categories for different laser modes, wavelengths or wavelength ranges.

3.2
optical density (spectral)
OD
$D(\lambda)$
logarithm to the base 10 of the reciprocal of the (spectral) transmittance

Note 1 to entry: Optical density is therefore expressed by the formula:

$$D(\lambda) = -\log_{10} \tau(\lambda)$$

where $\tau(\lambda)$ is the spectral transmittance.

Note 2 to entry: Practically OD can be considered a measure of the orders of magnitude of attenuation experienced by laser energy passing through a filter.

[SOURCE: ISO 4007:2018, 3.10.1.21 – Note 1 to entry and Note 2 to entry have been modified.]

3.3
pulse duration
time interval between the half-peak power points at the leading and trailing edges of a pulse

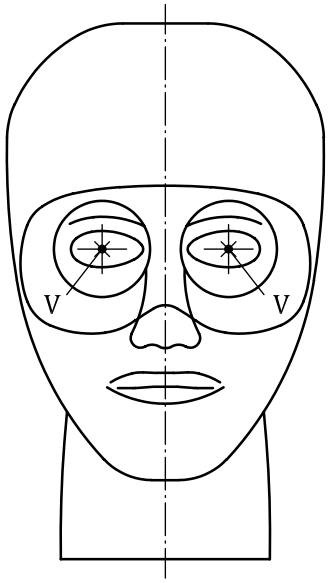
Note 1 to entry: For ultrashort pulses, pulse duration is linked to spectral bandwidth.

[SOURCE: IEC 60825-1:2014, 3.69 modified – "increment" changed to "interval" in the definition, Note 1 to entry added and "measured" removed from the definition.]

3.4
reference points (for testing)
visual centres
mounted lenses points on each lens corresponding to the intersection of the horizontal and vertical planes through the pupils of the appropriate headform when the protector is correctly fitted on it

Note 1 to entry: See Figure 1.

[SOURCE: ISO 4007:2018, 3.8.7 modified – internal references in ISO 4007 have been removed from the definition.]



Key

V reference points (for testing)

Figure 1 — Reference points for mounted lenses

4 Requirements for the protector[1)]

4.1 Performance requirements

4.1.1 Laser pulse and exposure duration

The laser pulse and exposure duration for which the protector is designated shall be determined in accordance with Table 1.

Table 1 — Laser type classification

Pulse/exposure duration s	Laser type
$\geq 10^{-1}$	C[ab]
$\geq 10^{-5}$ to $<10^{-1}$	P[a]
$\geq 10^{-10}$ to $<10^{-5}$	S[a]
$<10^{-10}$	U

[a] If the protector is intended for more than one type of laser emission, all intended pulse and exposure durations shall be stated. If the protector is used for all the laser pulse and exposure durations C, P and S for the same wavelength range and resistance category (see 4.1.4), the symbol A shall be used.

[b] C includes long-pulsed lasers and continuous wave lasers.

C = Continuous

P = Pulsed

S = Short Pulsed

U = Ultra Short Pulsed

1) For the purposes of this document, "protector" is used as a general term for eye protector and/or eye and face protectors used for laser protection.

4.1.2 Optical density (OD)

The optical density shall be defined for each wavelength of intended use of the protector.

In the case of protectors intended for use at more than one wavelength, the value of the optical density shall be specified for each wavelength and/or wavelength range.

Where the optical density is defined for a continuous range of wavelengths, the minimum value of the optical density in the wavelength range shall be specified.

For optical densities greater than 2,9, the optical density shall be expressed as a whole number that is no greater than the actual optical density minus the uncertainty of measurement and no greater than 8. For optical densities of 2,9 or less, the optical density shall be expressed to a maximum of one decimal place and indicate the rounded down value of the actual optical density minus the uncertainty of measurement.

The optical density shall be measured in accordance with 5.2. The optical density of any part of the filters or frames through which exposure to incident laser radiation could occur to the eyes (in the case of eye protectors) or the face (in the case of face protectors) shall not be less than the minimum value defined by the manufacturer, taking into account the uncertainty of measurement. See ISO 18526-2:2020, Annex A.

Special filters, for example filters with dielectric coatings, show an angle-dependent spectral transmittance. For these filters, the spectral transmittance shall be measured for the entire angular range from 0° to 30° angle of incidence at intervals no more than 5° (see 5.2). Where the specified optical density is limited to this range of angles, a written warning shall be included in the user information supplied with the protector (see 4.7).

4.1.3 Transmittance to short pulses

The spectral transmittance of the protectors intended for use with S and/or U pulse and exposure durations (see Table 1) shall be tested for saturable absorption using a laser with pulse or exposure duration corresponding to S and/or U (see Table 1) in accordance with 5.3.

4.1.4 Resistance category (RC)

For the intended use of the protector, the resistance category for the specified individual wavelength or wavelength range shall be determined. For protectors with multiple specified wavelengths or wavelength ranges, the resistance categories of each of the specified multiple wavelengths or each of the specified wavelength ranges shall be determined. The resistance category/categories shall be tested in accordance with 5.4.

The filter(s), side-shields and other parts of the frame or support that have a protective function shall maintain at least the specified optical density under the level of exposure specified in 5.4 for at least five seconds or at least 50 pulses, whichever is the longer period, delivered, if possible, within no more than 10 s.

Failure or decrease of protective properties could be due to burn, cracks, structural melting, photobleaching including reversible photobleaching, delamination of coatings, saturable absorption. This list is not exhaustive. Visible damage to the filter or the frame is permitted provided this does not affect its protective properties.

4.1.5 Luminous transmittance

The photopic luminous transmittance of the protective filters shall be specified and determined in accordance with 5.5. Where the luminous transmittance is less than 20 %, a warning shall be included in the information supplied with the protector [see 4.7 i)] that it has a low luminous transmission that may affect the wearer's awareness of other hazards.

4.1.6 Dynamic protection

For filters that exhibit an increase in optical density in response to an exposure to incident laser radiation, the time taken for the optical density to reach its full specified protective level should be determined and specified. Dynamic protectors should provide protection whenever laser radiation is incident on any protective part of the protector.

4.1.7 Field of view

When measured in accordance with ISO 18526-3:2020, 6.2, protectors, in the as-worn position, shall have a minimum unobstructed field of view in front of each eye of 40° temporally and 20° nasally in the horizontal meridian, and 30° superiorly and inferiorly in the vertical meridian.

4.1.8 Refractive power of filters and protectors

When assessed in accordance with ISO 18526-1:2020, Clause 6, the maximum refractive power of filters and protectors with no corrective effect shall be as given in Table 2.

Table 2 — Maximum refractive power of filters and protectors with no corrective effect

Spherical power	**Cylindrical power**	**Prism imbalance**		
		horizontal		**vertical**
Mean value of the focal powers (F_1, F_2) in the two principal meridians $(F_1 + F_2)/2$	Absolute difference between the focal powers (F_1, F_2) in the two principal meridians $\lvert F_1 - F_2 \rvert$	**base out**	**base in**	
dioptres (D)	dioptres (D)	prism dioptres (Δ)	prism dioptres (Δ)	prism dioptres (Δ)
±0,09	0,09	0,75	0,25	0,25

The tests for determining the refractive power and prism imbalance of filters and protectors shall be carried out in accordance with ISO 18526-1:2020, Clause 6.

4.2 Construction of protectors

All parts of the protector shall be designed so that no hazardous laser radiation can penetrate from the sides, or from above or below the horizontal plane. This requirement is met if, for a horizontal angular range α from −50° (nasal side) to +90° (temporal side), the specified level of protection is provided within the vertical angular range β, where β is subtended at the corneal vertex and satisfies the following two conditions.

The upward limit of β_u (measured upwards from the horizontal plane), in degrees (°), shall be at least, as given by Formula (1):

$$\beta_u = 55 - 0{,}0013 \cdot (\alpha - 12)^2 - 1{,}3 \times 10^{-6} \cdot (\alpha - 12)^4 \quad (1)$$

The downward limit of β_d (measured downwards from the horizontal plane), in degrees (°), shall be at least, as given in Formula (2):

$$\beta_d = -70 + 10^{-5} \cdot (\alpha - 22)^2 + 2{,}3 \times 10^{-6} \cdot (\alpha - 22)^4 \quad (2)$$

NOTE The protected area does not apply to filters having limited angular coverage, e.g. dielectric interference coatings.

The filter and frame shall meet the requirements of ISO 16321-1:2021, 6.6, for frame transmittance, paying particular attention to air vents or gaps in the protector.

Testing shall take place on each of the headforms, in accordance with ISO 18526-4, specified by the manufacturer for which a conformity claim is intended. If a headform is not specified, then testing shall be carried out on the 1-M headform of ISO 18526-4.

4.3 Robustness of protectors

4.3.1 Basic requirement

Filters shall satisfy the requirement for minimum robustness as specified in ISO 16321-2:2021, 4.3.4.

4.3.2 Optional requirements

For applications where mechanical strength of filters and protectors is required, the basic impact requirement of ISO 16321-1:2021, 7.4 or one of the high speed impact resistance requirements specified in ISO 16321-1:2021, 7.10 shall be met.

It is sometimes necessary to have a lens to provide the mechanical protection behind the filter for protection against laser radiation. In ISO 16321-1, the mechanical requirements apply to the element nearer the eye.

4.4 Quality of material and surface of filters

4.4.1 Material and surface defects

The tests for determining material and surface defects of filters shall be carried out in accordance with ISO 18526-3:2020, 6.6, except for a 5 mm wide portion around the edge of the filter which shall be excluded from the assessment area. Filters shall be free from any material or surface defects likely to impair the intended use, such as bubbles, scratches, inclusions, dull spots, mould marks, scoring or other defects originating from the manufacturing process. No holes are allowed anywhere in the filters.

4.4.2 Scattered light

Wide angle scatter of filters with luminous transmittance equal to or greater than 20 % shall not exceed 3 %.

If the luminous transmittance is equal to or greater than 20 %, measure the wide angle scatter in accordance with ISO 18526-2:2020, 14.1.

If the luminous transmittance is less than 20 %, measure the narrow angle scatter in accordance with ISO 18526-2:2020, 14.2.

The reduced luminance coefficient l^* (narrow angle scatter) of a filter with luminous transmittance below 20 % shall be determined in accordance with ISO 18526-2:2020, 14.2 and shall not be greater than:

$$l^* = 0{,}5\,(\mathrm{cd/m^2})/\mathrm{lx} \tag{3}$$

4.5 Environmental stability

4.5.1 General

The following subclauses apply to both the filters and those parts of the frame that perform a laser protection function.

4.5.2 Filter and protector resistance to heat and humidity

After exposing the protector to the conditions described in 5.7, the optical density, as described in 4.1.2, shall not fall below the specified value. The luminous transmittance of the filter, as described in 4.1.5, shall not fall by more than 10 % of the specified value, as given in Formula (4):

$$\left|\frac{\Delta\tau_v}{\tau_v}\right| \leq 10\,\% \tag{4}$$

where

τ_v is the initial luminous transmittance;

$\Delta\tau_v$ is the change in luminous transmittance

4.5.3 Stability to ultraviolet radiation

After exposure to ultraviolet radiation in accordance with ISO 18526-3:2020, 6.8.2, the properties of protectors shall not change to such an extent that they no longer satisfy the requirements of 4.1. The relative change in the luminous transmittance of the filter, τ_v, shall be ≤10 % [see Formula (4)].

If the luminous transmittance of laser protective filters decreases by more than 10 % but the optical density OD value(s) remain(s) within the range specified in 4.1.2, a second irradiation shall be performed in accordance with ISO 18526-3:2020, 6.8.2, on the same sample. The relative change of luminous transmittance due to the second irradiation shall not be greater than 10 % and the optical density OD value(s) shall remain within the range specified in 4.1.2.

After exposure to ultraviolet radiation in accordance with ISO 18526-3:2020, 6.8.2, protectors shall meet the requirements of 4.4.2 for narrow or wide angle scatter. Measurement of narrow or wide angle scatter is carried out after the second irradiation, if that was needed, in other cases after the first irradiation.

4.5.4 Resistance of filters and frames to ignition by contact with hot surfaces

The test shall be carried out on the frame and lenses in accordance with ISO 18526-3:2020, 6.10. In the test, the filters and frames shall not ignite or continue to glow.

4.6 Marking

4.6.1 Marking requirements

Permissible marking combinations of optical density OD and resistance category are given in the shaded area of Table 3. OD or resistance category values outside the shaded area in Table 3 shall be marked with the corresponding maximum value within the shaded area.

Table 3 — Permissible combinations (shaded area) in marking of the optical density OD and the resistance category

<table>
<tr><th rowspan="2">Resistance category</th><th colspan="8">Optical density</th></tr>
<tr><th>OD < 1</th><th>OD1-2</th><th>OD3</th><th>OD4</th><th>OD5</th><th>OD6</th><th>OD7</th><th>OD8</th></tr>
<tr><td>1 and 2</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Marked with OD5</td></tr>
<tr><td>3</td><td rowspan="4">Marked with resistance category 2</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Marked with OD7</td></tr>
<tr><td>4</td><td rowspan="3">Marked with resistance category 3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td rowspan="2">Marked with resistance category 4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>Marked with resistance category 5</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Examples for protectors whose measured properties lie in the non-shaded marking area: If a protector has measured OD2 and measured resistance category 5, this would lie outside the shaded area. OD cannot be marked at greater than the measured value and thus the protector should be marked as OD2 and resistance category 3, derived by looking at the table entry for OD1-2 and measured resistance category 5. On the other hand, if a protector has measured OD8 and resistance category 2, this would lie outside the shaded area. Resistance category cannot be marked at greater than the measured value and thus the protector should be marked OD5 and with resistance category 2, derived by looking at the table entry for measured OD8 and resistance category "1 and 2".

Protectors shall be clearly and permanently marked on any suitable and appropriate part of the product with the following information:

a) the wavelength(s) and/or the upper and lower limits of the wavelength range(s) in nanometres for which the protection is specified;

b) the optical density at the specified wavelength(s) and/or over each wavelength range for which the protection is specified (see 4.1.2).

c) the type or types of laser emission as specified in Table 1;

d) for C, P and S, the resistance category and, if tested for pulse duration $<10^{-10}$ s the marking U. If the protector is intended for different laser pulse and exposure durations or for different wavelengths, the resistance category should be specified for each application. The specific test conditions for the marking U are to be included in the user instruction and information per 4.7 f) (see Note).

NOTE U-rating cannot be extrapolated across wide ranging laser parameters (see 5.4), so no value for the resistance category is given.

e) if the protector is tested on a headform other than the default 1-M;

f) the label "PATIENT" if the protector is for use by patients only;

g) the number of this document ISO 19818-1;

h) the name or trade mark of the manufacturer;

i) the impact level according to ISO 16321-1:2021, Table 18, if applicable.

The information a) to i) shall be marked in the order listed and in a single line, or separated into two groups where a) to d) are marked together as one group in that order in a single line, and e) to i) are marked as a second group in that order on a different line or in that order on a different part of the protector.

The information a) to d) shall be grouped together for all applicable wavelengths.

Where the protector is intended for use at more than one individual wavelength and/or in more than one wavelength range then the individual wavelengths and/or wavelength ranges shall be marked consecutively followed by the marks for b), c), and d) provided that each of b), c) and d) are identical for all applicable wavelengths. Where this is not the case, a), b), c) and d) shall be marked as a separate group for each separate wavelength or wavelength range, and all such separate groups shall be marked in close proximity on the protector.

In all cases where multiple wavelengths and/or wavelength ranges are marked consecutively, the unit 'nm' (for nanometre) need only be marked once, following the last wavelength marked in that group.

4.6.2 Marking syntax and examples of marking

The following syntax rules shall apply (see Figure 2 and Figure 3 for pictorial representation):

The wavelength, optical density OD, and resistance category markings on the product, together with the standard marking and (if applicable) the certification marking:

— shall collectively be termed a rating group.

A rating group shall comprise:

— one or more rating blocks; and

— a standard and certification block.

A rating block shall comprise:

— a wavelength block; followed by a space and then

— an optical density (OD) block; followed by a space and then

— a resistance category block.

A standard and certification block shall comprise:

— the characters "ISO 19818-1"; followed by a space and then

— if applicable the certification marking which may be an alpha numeric string of any length.

NOTE 1 An example of a certification marking (in Europe) is "CE".

If there is more than one rating block in a rating group, then either:

— each rating block should be on a new line; or

— the "|" symbol should be used as a separator.

A wavelength block shall comprise:

— a list of individual wavelength(s) and / or wavelength range(s) separated by spaces;

— with the unit being included, and the unit shall be nm.

An individual wavelength shall be shown as:

— the wavelength, followed by the letters "nm", with no spaces in the string.

A wavelength range shall be shown as:

— the lower wavelength, then a dash, then the upper wavelength, then the letters "nm", with no spaces in the string.

An optical density (OD) block shall comprise:

— the letters OD followed by a single number.

NOTE 2 This only relates to the marking. OD is marked rounded down, e.g. 2,5 as 2.

A resistance category (RC) block shall comprise:

— one or more resistance category sub blocks separated by spaces.

A resistance category sub block shall comprise:

— one or more of the letters C, P or S followed by a single digit, followed (if the filter is rated for the U test condition) by a space and then the letter U;

— if the resistance category is the same for all of test conditions C, P, and S, then “CPS” may be abbreviated to “A”.

NOTE 3 The reason that no resistance category is specified for test condition U is that it is not possible to specify one set of resistance category test conditions for U protectors that will apply to all pulse durations and optical densities.

It shall be permissible to split the markings over various areas of the product, providing the aforementioned rules are met.

The ordering of markings should generally be:

— in wavelength order, then test condition order - i.e. the respective resistance category/categories for test conditions C, P, and S, followed by (if the filter is rated for test condition U) the letter U;

— if manufacturer wishes to put popular wavelengths (e.g. 1064nm) towards the front that is allowed.

However the manufacturer shall:

— always respect the CPSU ordering;

— e.g. the following shall not be allowed: 1 064nm OD6 P5 C4 ISO 19818-1 XX

NOTE 4 In all the examples in this sub clause the certification marking is shown as XX.

Examples of syntax and marking:

EXAMPLE 1 A marking of 1000-1300nm OD5 S4

with ISO 19818 -1 XX marked elsewhere on the protector.

These marks indicate:

— the wavelength range covered is 1000-1300nm

— the optical density (OD) is at least 5 for the intended exposure type across this wavelength range

— intended for a S laser, pulse duration $\geq 10^{-10}$ s to $< 10^{-5}$ s

— resistance category 4

— ISO 19818-1 standard

— XX - the certification marking

EXAMPLE 2 550-750nm 1000-1300nm OD5 P4, with ISO 19818-1 XX marked on the protector.

EXAMPLE 3 10600nm OD6 C5, with ISO 19818-1 XX marked on the protector.

EXAMPLE 4 880nm OD4 C2, with ISO 19818-1 XX and PATIENT marked on the protector

EXAMPLE 5 A simple example of the required marking for the OD and resistance category is:

1000-1300nm OD5 S4 U

EXAMPLE 6 A more complex example is:

400-520nm OD4 CP3

500-550nm OD5 PS4

633nm OD3 C2

1000-1500nm OD4 S3

1064nm OD6 S5

EXAMPLE 7 An alternative presentation, using the "|" separator is as follows:

400-520nm OD4 CP3 | 500-550nm OD5 PS4 | 633nm OD3 C2 | 1000-1500nm OD4 S3 | 1064nm OD6 S5

Presented as a syntax this example (including the standard number and the certification marking) appears as shown in Figure 2.

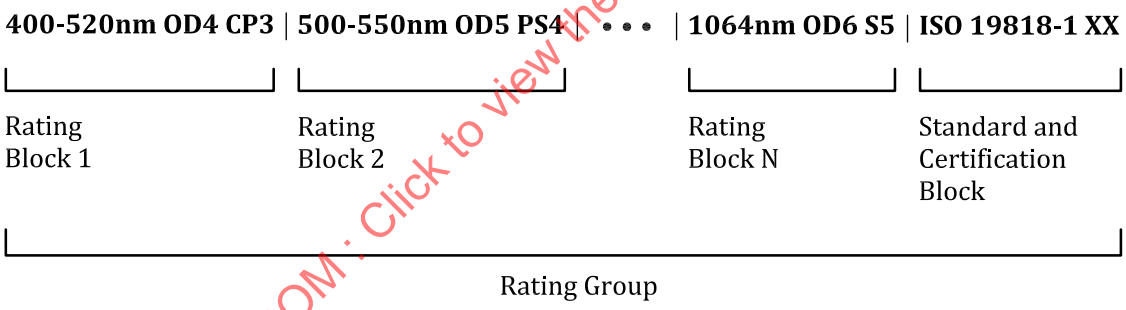


Figure 2 — Example syntax for protector rating block and group

However, to cater for full generality, more complex rating block formats shall be allowed. An example is shown in Figure 3.

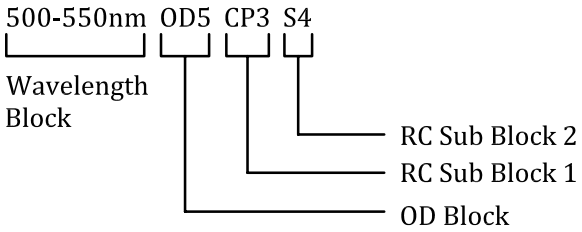


Figure 3 — Example of marking a more complex rating block

4.7 Manufacturer's instruction and information

The manufacturer shall provide with each protector at least the following information either in written or electronic form:

a) general guidance on the selection and use of laser eye or face protection, including the need to base this on the results of a risk assessment, and a recommendation to refer to a specific relevant national or international guidance document;

b) clear indication that patients' eyewear should not be used by a laser operator;

c) a warning, using the following (or equivalent) wording: "Warning: The selection of appropriate protection must be based on both the optical density (OD) necessary to reduce the incident laser exposure to a safe level, and the ability of the protector to withstand the incident laser exposure without failure, as indicated by the resistance category. Inappropriate combinations of optical density and resistance category, in particular, a high level of optical density in combination with an insufficiently high resistance category, should not be used";

d) a warning using the following (or equivalent) wording: "Warning: This product is only intended to protect you from accidental exposure to a laser radiation. NEVER use laser protection to look deliberately into the source of a laser radiation. Such viewing may damage the protector and result in serious injury. Accidental exposure to laser radiation may also burn the skin";

e) the words, "Modification of this product may adversely affect the product's performance";

f) an example of reproduction of the marking required in 4.6.1 and an explanation of its meaning, included, if tested, the test conditions and limitations relating to the U-marking, e. g. wavelength, beam diameter, repetition rate and duty cycle;

g) The increased temperature range, when applicable, over which the performance of the protector meets the specification;

h) a declaration of the protector's specification in terms of the parameters defined in 4.1;

i) the value, expressed as a percentage, of the luminous transmittance of the filter(s) and, where this value is less than 20 %, the following (or equivalent) wording: "Warning: this laser protector has a reduced luminous transmission that may affect the wearer's awareness of other hazards";

NOTE Visible light transmittance (VLT) is frequently used as an optional term in addition to luminous transmittance.

j) if appropriate, a warning using the following (or equivalent) wording: "Warning: This laser protector may affect colour perception". It can be assumed that any protector providing protection in the visible waveband will have an effect upon colour perception and needs to be accompanied by this warning;

k) a warning, where applicable, that protection is limited to the angular range 0° to 30°;

l) The headform(s) for which the protector is appropriate (see 4.2);

m) instructions for the inspection, use, care, storage, cleaning and disinfection of the protector, and guidance on when and under what circumstances it should be replaced;

n) the name and address of the manufacturer or supplier of the protector, and either a contact telephone number or email address from where further information and advice on the protector may be obtained;

o) a warning that the information should be kept with the product and not discarded;

p) "Not for protection against mechanical hazards" unless the protector has been marked with an impact level according to 4.6.1 i) or "ISO 16321" to denote basic impact level.

Specific national or regional regulations with regard to information to be supplied by the manufacturer might have additional and/or different mandatory requirements. For example, different wording of the warning statements but with the same intent can be permissible.

4.8 Requirements not mandatory for protectors worn by patients during medical or aesthetic treatment with lasers

The Subclauses listed in Table 4 are not mandatory for protectors intended to be used by patients undergoing medical or aesthetic treatment with lasers.

Table 4 — Subclauses not mandatory for protectors intended for patients

Subclause	Description
4.1.5	Luminous transmittance
4.1.7	Field of view
4.1.8	Refractive power of filters and protectors
4.4	Quality of materials and surface of filters

5 Test methods

5.1 General

The protectors described in this document are intended for use at ambient temperatures of (23 ± 5) °C, unless specified in particular requirement(s). Where a manufacturer claims a greater temperature range, testing shall be performed at the extremes of that temperature range, and information shall be supplied to the user in accordance with 4.7 g).

The testing schedule in Table 5 shall be applied to testing of filters, frames and complete protectors. The sequence of testing 1 to 9 and 13 to 16 may be changed. At least 16 filters or 8 complete protectors are required for testing. If testing for several wavelengths (wavelength ranges) or testing conditions according to 5.4 and/or several optional requirements are required, more than 16 samples may be necessary. Testing may be carried out on individual parts of the protector before assembly.

Table 5 — Test schedule for filters, frames and complete protectors, for protection against laser radiation

Number of testing	Requirement	Subclause	Number of filters, frame samples and complete protectors				
1	Marking	4.6	1				
2	Material and surface defects	4.4.1	3	3			
3	Field of view	4.1.7	1 frame or complete protector				
4	Construction of filters	4.2	1				
5	Scattered light before test 10 and 11	4.4.2	3	3			
6	Luminous transmittance before test 10 and 11	5.5	3	3			

Note Empty field – means no testing specified

[a] Additional requirements are tested as stated in ISO 18526-3. The number of frames depends on the test method.

Table 5 *(continued)*

Number of testing	Requirement	Subclause	Number of filters, frame samples and complete protectors				
7	Refractive power before test 10 and 11	4.1.8	3	3			
8	Prism imbalance	4.1.8	3 frames				
9	Spectral optical density (OD) at wavelength λ before test 10 and 11	5.2	3	3	3 filters/frames per wavelength and test condition	3 filters/frames per wavelength and test condition	
10	Resistance to ultraviolet radiation	4.5.3	3 filters				
11	Protection at extremes of temperature	5.7		3			
12	Quality of material and surface	4.4.1	3	3			
13	Scattered light after test 10 and 11	4.4.2	3	3			
14	Luminous transmittance after test 10 and 11	5.5	3	3			
15	Refractive power after test 11	4.1.8		3			
16	Spectral optical density (OD) at wavelength λ after test 10	5.2	3				
17	Mechanical strength	4.3			10 or 12	depends on the requirement	
18	Resistance of filters and frames to laser radiation λ	5.4			3 filters/frames per wavelength and test condition	3 filters/frames per wavelength and test condition	
19	Resistance to ignition	4.5.4			filters/ frames 7-9		
20	Transmittance of short pulses	5.3					
21	Dynamic protection	4.1.6					
22	Optional requirements	[a]				depends on requirement/ test procedure	

Note Empty field – means no testing specified

[a] Additional requirements are tested as stated in ISO 18526-3. The number of frames depends on the test method.