



# SLOVENSKI STANDARD

## SIST EN 207:2010

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Nadomešča:

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**Oprema za osebno varovanje oči - Filtri in varovala za zaščito oči pred laserskimi žarki (očala za zaščito pred laserskimi žarki)**

Personal eye-protection equipment - Filters and eye-protectors against laser radiation (laser eye-protectors)

Persönlicher Augenschutz - Filter und Augenschutzgeräte gegen Laserstrahlung (Laserschutzbrillen)

Protection individuelle de l'oeil - Filtres et protecteurs de l'oeil contre les rayonnements laser (lunettes de protection laser)

**Ta slovenski standard je istoveten z: EN 207:2009**

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EUROPEAN STANDARD  
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EUROPÄISCHE NORM

**EN 207**

December 2009

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English Version

## Personal eye-protection equipment - Filters and eye-protectors against laser radiation (laser eye-protectors)

Protection individuelle de l'oeil - Filtres et protecteurs de  
l'oeil contre les rayonnements laser (lunettes de protection  
laser)

Persönlicher Augenschutz - Filter und Augenschutzgeräte  
gegen Laserstrahlung (Laserschutzbrillen)

This European Standard was approved by CEN on 14 November 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

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## Contents

Page

Foreword.....	4
<b>1 Scope .....</b>	<b>5</b>
<b>2 Normative references .....</b>	<b>5</b>
<b>3 Requirements .....</b>	<b>5</b>
3.1 Spectral transmittance of filters and frames .....	5
3.2 Luminous transmittance of filters .....	5
3.3 Resistance of filters and frames to laser radiation .....	5
3.4 Refractive values of filters and eye-protectors .....	6
3.5 Quality of material and surface of filters .....	7
3.5.1 Material and surface defects .....	7
3.5.2 Diffusion of light .....	7
3.6 Stability of filters and eye-protectors to ultraviolet radiation and elevated temperature .....	7
3.6.1 Stability to ultraviolet radiation .....	7
3.6.2 Stability at elevated temperature .....	7
3.7 Resistance of filters and frames to ignition by contact with hot surfaces .....	7
3.8 Field of vision of eye-protectors .....	7
3.9 Construction of filters and frames .....	8
3.10 Mechanical strength of eye-protectors.....	8
3.10.1 Basic requirement.....	8
3.10.2 Optional requirements .....	8
<b>4 Testing .....</b>	<b>8</b>
4.1 General.....	8
4.2 Spectral transmittance of filters and frames .....	10
4.3 Luminous transmittance of filters .....	10
4.4 Resistance of filters and frames to laser radiation .....	10
4.5 Refractive value of filters and eye-protectors .....	11
4.6 Quality of material and surface of filters .....	11
4.6.1 Material and surface defects .....	11
4.6.2 Diffusion of light .....	11
4.7 Stability to UV radiation and stability to elevated temperature .....	11
4.7.1 Stability to UV radiation .....	11
4.7.2 Stability to elevated temperature .....	11
4.8 Resistance of filters and frames to ignition by contact with hot surfaces .....	11
4.9 Field of vision of eye-protectors .....	12
4.10 Determination of the protected range.....	12
4.11 Frames .....	13
4.12 Mechanical strength .....	13
<b>5 Information supplied by the manufacturer .....</b>	<b>13</b>
<b>6 Marking .....</b>	<b>14</b>
6.1 Eye-protectors.....	14
6.2 Filters .....	16
<b>Annex A (informative) Principle .....</b>	<b>17</b>
A.1 Limit values and time base .....	17
A.2 Beam areas.....	18
A.3 Angle dependence .....	19
A.4 Example test report .....	19
<b>Annex B (informative) Recommendations for the use of laser radiation eye-protectors .....</b>	<b>22</b>
B.1 General.....	22

<b>B.2</b>	<b>Types of lasers</b> .....	<b>22</b>
<b>B.3</b>	<b>Determination of the scale numbers</b> .....	<b>23</b>
<b>B.3.1</b>	<b>General</b> .....	<b>23</b>
<b>B.3.2</b>	<b>Continuous wave laser (D)</b> .....	<b>23</b>
<b>B.3.3</b>	<b>Pulsed lasers (I, R), pulse duration <math>\geq 10^{-9}</math> s</b> .....	<b>23</b>
<b>B.3.4</b>	<b>Mode coupled lasers (M), pulse duration <math>&lt; 10^{-9}</math> s</b> .....	<b>25</b>
<b>B.4</b>	<b>Time base</b> .....	<b>25</b>
<b>B.5</b>	<b>Filters in appliances</b> .....	<b>26</b>
<b>Annex C</b>	<b>(informative) Significant technical changes between this European Standard and the previous edition</b> .....	<b>27</b>
<b>Annex ZA</b>	<b>(informative) Relationship between this European Standard and the Essential Requirements of EU Directive 89/686/EEC</b> .....	<b>28</b>
<b>Bibliography</b>	.....	<b>29</b>

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EN 207:2009 (E)

## Foreword

This document (EN 207:2009) has been prepared by Technical Committee CEN/TC 85 “Eye protective equipment”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2010, and conflicting national standards shall be withdrawn at the latest by June 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 207:1998.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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## 1 Scope

This European Standard applies to eye-protectors used for protection against accidental exposure to laser radiation as defined in EN 60825-1:2007 in the spectral range 180 nm (0,18  $\mu\text{m}$ ) to 1 000  $\mu\text{m}$ . It defines the requirements, test methods and marking. A guide is given in Annex B for the selection and use of laser eye-protectors.

This European Standard does not apply to protectors for intentional exposure to laser radiation.

EN 208 applies for laser adjustment eye-protectors.

NOTE Before selecting eye protection according to this European Standard, a risk assessment should first be undertaken (see Annex B).

## 2 Normative references

The following referenced documents are indispensable for the application 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.

EN 166:2001, *Personal eye-protection — Specifications*

EN 167:2001, *Personal eye-protection — Optical test methods*

EN 168:2001, *Personal eye-protection — Non-optical test methods*

EN 60825-1:2007, *Safety of laser products — Part 1: Equipment classification and requirements (IEC 60825- 1:2007)*

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ISO 11664-1:2007, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO 11664-2:2007, *Colorimetry — Part 2: CIE standard illuminants*

## 3 Requirements

### 3.1 Spectral transmittance of filters and frames

When tested according to 4.2, the maximum spectral transmittance at the wavelength(s) or in the wavelength range(s) of protection shall not exceed the values specified in Table 1 for the applicable scale number.

### 3.2 Luminous transmittance of filters

When assessed in accordance with 4.3, the luminous transmittance of the filter relative to the D65 standard illuminant (see ISO 11664-2:2007) shall be at least 20 %. However, luminous transmittance lower than 20 % may be accepted provided that the manufacturer supplies information related to the increase of the intensity of illumination at the relevant workplace in accordance with Clause 5.

### 3.3 Resistance of filters and frames to laser radiation

When tested according to 4.4, the filters and frames shall meet the requirements of 3.1 and shall not lose their protective effect under the influence of laser radiation of the power ( $E$ ) or energy density ( $H$ ) as specified in Table 1 and shall not show any induced transmission (reversible bleaching). No splinters shall come away from the side of the filter facing the eye under the influence of the laser radiation. Any melting or other damage

## EN 207:2009 (E)

of the surface during the course of irradiation is not considered negative if the protective effect is still maintained.

**Table 1 — Scale numbers (maximum spectral transmittance and resistance to laser radiation) of the filters and/or eye-protectors against laser radiations**

Scale number	Maximum spectral transmittance at the laser wavelength $\tau(\lambda)$	Power (E) and energy (H) density for testing the protective effect and resistance to laser radiation in the wavelength range								
		180 nm to 315 nm			> 315 nm to 1 400 nm			> 1 400 nm to 1 000 $\mu\text{m}$		
		For test condition/pulse duration in seconds (s)								
		D $\geq 3 \times 10^4$	I, R $10^{-9}$ to $3 \times 10^4$	M $< 10^{-9}$	D $> 5 \times 10^{-4}$	I, R $10^{-9}$ to $5 \times 10^{-4}$	M $< 10^{-9}$	D $> 0,1$	I, R $10^{-9}$ to 0,1	M $< 10^{-9}$
		$E_D$ W/m <sup>2</sup>	$H_{I,R}$ J/m <sup>2</sup>	$E_M$ W/m <sup>2</sup>	$E_D$ W/m <sup>2</sup>	$H_{I,R}$ J/m <sup>2</sup>	$H_M$ J/m <sup>2</sup>	$E_D$ W/m <sup>2</sup>	$H_{I,R}$ J/m <sup>2</sup>	$E_M$ W/m <sup>2</sup>
LB1	$10^{-1}$	0,01	$3 \times 10^2$	$3 \times 10^{11}$	$10^2$	0,05	$1,5 \times 10^{-3}$	$10^4$	$10^3$	$10^{12}$
LB2	$10^{-2}$	0,1	$3 \times 10^3$	$3 \times 10^{12}$	$10^3$	0,5	$1,5 \times 10^{-2}$	$10^5$	$10^4$	$10^{13}$
LB3	$10^{-3}$	1	$3 \times 10^4$	$3 \times 10^{13}$	$10^4$	5	0,15	$10^6$	$10^5$	$10^{14}$
LB4	$10^{-4}$	10	$3 \times 10^5$	$3 \times 10^{14}$	$10^5$	50	1,5	$10^7$	$10^6$	$10^{15}$
LB5	$10^{-5}$	$10^2$	$3 \times 10^6$	$3 \times 10^{15}$	$10^6$	$5 \times 10^2$	15	$10^8$	$10^7$	$10^{16}$
LB6	$10^{-6}$	$10^3$	$3 \times 10^7$	$3 \times 10^{16}$	$10^7$	$5 \times 10^3$	$1,5 \times 10^2$	$10^9$	$10^8$	$10^{17}$
LB7	$10^{-7}$	$10^4$	$3 \times 10^8$	$3 \times 10^{17}$	$10^8$	$5 \times 10^4$	$1,5 \times 10^3$	$10^{10}$	$10^9$	$10^{18}$
LB8	$10^{-8}$	$10^5$	$3 \times 10^9$	$3 \times 10^{18}$	$10^9$	$5 \times 10^5$	$1,5 \times 10^4$	$10^{11}$	$10^{10}$	$10^{19}$
LB9	$10^{-9}$	$10^6$	$3 \times 10^{10}$	$3 \times 10^{19}$	$10^{10}$	$5 \times 10^6$	$1,5 \times 10^5$	$10^{12}$	$10^{11}$	$10^{20}$
LB10	$10^{-10}$	$10^7$	$3 \times 10^{11}$	$3 \times 10^{20}$	$10^{11}$	$5 \times 10^7$	$1,5 \times 10^6$	$10^{13}$	$10^{12}$	$10^{21}$

The symbols D, I, R and M relative to the test conditions are explained in Table 4.

### 3.4 Refractive values of filters and eye-protectors

When assessed in accordance with 4.5, the maximum refractive values of filters and eye-protectors with no corrective effect shall be as given in Table 2. The maximum refractive values apply to the range specified in 7.1.2.1 of EN 166:2001.

**Table 2 — Maximum refractive values of filters and eye-protectors with no corrective effect**

Spherical power $\text{m}^{-1}$	Astigmatic power $\text{m}^{-1}$	Prismatic power difference		
		horizontal		vertical
		base out cm/m	base in cm/m	cm/m
$\pm 0,09$	0,09	0,75	0,25	0,25



### 3.5 Quality of material and surface of filters

#### 3.5.1 Material and surface defects

The material and surface defects of filters shall be assessed in accordance with 4.6.1.

Except for a marginal area of 5 mm wide, 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.

#### 3.5.2 Diffusion of light

The reduced luminous coefficient  $I^*$  of a filter, determined in accordance with 4.6.2, shall not be greater than

$$I^* = 0,50 \frac{\text{cd} / \text{m}^2}{\text{lx}} \quad (1)$$

### 3.6 Stability of filters and eye-protectors to ultraviolet radiation and elevated temperature

#### 3.6.1 Stability to ultraviolet radiation

When exposed to ultraviolet radiation in accordance with 4.7.1, the properties of filters and eye-protectors shall not change to such an extent that they can no longer satisfy the requirements of 3.1, 3.2, 3.4 and 3.5. The relative change in the luminous transmittance shall be  $\leq 10\%$ :

$$\left| \frac{\Delta \tau_v}{\tau_v} \right| \leq 10\% \quad (2)$$

The spectral transmittance for the laser wavelengths shall, however, in no case exceed the maximum spectral transmittance corresponding to the indicated scale number.

#### 3.6.2 Stability at elevated temperature

After exposure to elevated temperature in accordance with 4.7.2, filters and eye-protectors shall satisfy the requirements of 3.1, 3.2, 3.4 and 3.5. The relative change in the luminous transmittance shall not exceed 5%:

$$\left| \frac{\Delta \tau_v}{\tau_v} \right| \leq 5\% \quad (3)$$

The spectral transmittance for the laser wavelength shall, however, in no case exceed the maximum spectral transmittance corresponding to the indicated scale number.

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

When tested in accordance with 4.8, the filters and frames shall not ignite or continue to glow.

### 3.8 Field of vision of eye-protectors

Eye-protectors shall have a clear field of vision of at least  $40^\circ$  in the vertical and horizontal directions for each eye when measured in accordance with 4.9 (see Figure 1).

**EN 207:2009 (E)****3.9 Construction of filters and frames**

Filters shall be constructed so that when tested in accordance with 4.4 followed by a visual inspection no splinters are detached from the side of the filter facing the eye. If the filters consist of several individual filters, they shall be assembled in such a way that they cannot be interchanged.

Filters shall not be interchangeable in the frame. An exception is possible if the protection to laser radiation is determined only by the filter(s) and no part of the frame lies inside the protected range as defined below. In this case the marking of the eye-protector shall be on the filter(s) and there is no requirement for the frame to satisfy 3.3 on resistance to laser radiation.

The frame shall be designed so that no laser radiation can penetrate from the side. This requirement is met if for the horizontal angle range  $\alpha$  from  $-50^\circ$  (nasal side) to  $+90^\circ$  (temporal side) the vertical angle range  $\beta$  is protected within the following limit angles in degrees ( $^\circ$ ).

The upward limit  $\beta_u$  of the protected range shall be:

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

The downward limit  $\beta_l$  of the protected range shall be:

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

Testing shall be done in accordance with 4.10.

**3.10 Mechanical strength of eye-protectors****3.10.1 Basic requirement**

Filters for protection against laser radiation shall satisfy the requirement for minimum robustness as specified in 7.1.4.1 of EN 166:2001.

The frames of the eye-protectors shall satisfy the requirements of 7.1.4.2 or 7.2.2 of EN 166:2001.

**3.10.2 Optional requirements**

If the mechanical strength of filters and eye-protectors against laser radiation is required to satisfy more stringent requirements, the requirements specified in 7.1.4.2 or the requirements specified in 7.2.2 of EN 166:2001 shall be met.

**4 Testing****4.1 General**

The testing schedule in Table 3 shall be applied to testing of filters, frames and complete eye-protectors. The sequence of testing 1 to 9 and 13 to 16 may be changed. At least 16 filters or eight complete eye-protectors are required for testing. If testing for several wavelengths (wavelength ranges) or testing conditions according to 4.4 and/or several optional requirements has to be done, more than 16 samples may be necessary.

Table 3 —Test schedule for filters, frames and complete eye-protectors for protection against laser radiation

Order of testing	Requirement	According to clause	Number of filter/frame samples			
			3	3	10	Depends on specification/ requirement
1	Marking	6	+	+		
2	Material and surface defects	3.5.1	+	+		
3	Field of vision	3.8	1 frame			
4	Construction of filters and frames	3.9	+	+		
5	Frames	3.9	+	+		
6	Diffusion of light	3.5.2	+	+		
7	Luminous transmittance	3.2	+	+		
8	Refractive values	3.4	+	+		
9	Prismatic power difference	3.4	3 frames			
10	Spectral transmittance at wavelength $\lambda$	3.1	+	+	3 filters/frames per $\lambda$ and test condition	3 filters/frames per $\lambda$ and test condition
11	Stability to UV radiation	3.6.1	+			
12	Stability to elevated temperature	3.6.2	+			
13	Material and surface defects	3.5.1	+	+		
14	Diffusion of light	3.5.2	+	+		
15	Luminous transmittance	3.2	+	+		
16	Refractive values	3.4	+			
17	Spectral transmittance	3.1	+	+		
18	Mechanical strength	3.10			+	
19	Resistance to laser radiation and spectral transmittance at wavelength $\lambda$	3.3			3 filters/frames per $\lambda$ and test condition	3 filters/frames per $\lambda$ and test condition
20	Ignition	3.7			3 filters/frames	
21	Optional requirements as given in EN 166:2001	according to applicable clause of EN 166:2001				depends on requirement/ test procedure

Explanation of the symbols:  
+ Testing to be carried out on the indicated specimen;  
Empty field No testing specified.

## EN 207:2009 (E)

## 4.2 Spectral transmittance of filters and frames

The spectral transmittance shall be determined for normal incidence. Filters with angular-dependent transmittance (such as interference layers) for the wavelength range from 400 nm to 1 400 nm shall be measured at angles of incidence between 0° and 30° with polarized radiation and an orientation of the polarization direction giving the highest value of the spectral transmittance. Filters with angular-dependent transmittance for other wavelengths shall be measured at angles of incidence between 0° and 90° with polarized radiation. In this case, the scale number results from the highest of the spectral transmittance values measured.

Testing shall be done in accordance with EN 167:2001, Clause 6.

## 4.3 Luminous transmittance of filters

The luminous transmittance shall be determined for normal incidence, relative to the D65 standard illuminant (see ISO 11664-1:2007 and ISO 11664-2:2007).

The test shall be performed according to EN 167:2001, Clause 6.

## 4.4 Resistance of filters and frames to laser radiation

The test shall be carried out with laser radiation of the specified wavelengths and the power and energy densities given in Table 1. The spectral transmittance shall be measured for each laser wavelength during the exposure to laser radiation.

The values of energy density ( $H$ ) in Table 1 for testing the resistance against laser radiation for pulsed lasers (I, R, M) shall be multiplied with the factor  $N^{1/4}$ , where  $N$  is the number of pulses in 5 s.

The frame shall be exposed to radiation at the point of least thickness for each of the materials used (with the exception of headbands).

The diameter  $d_{63}$  of the laser beam during this test shall be  $(1 \pm 0,1)$  mm.

For pulse durations  $< 1$  ns, the diameter  $d_{63}$  of the laser beam during this test shall be  $\geq 0,5$  mm.

In the case of rectangular beams, the dimensions specified apply to the shortest side of the rectangle.

The duration of the test shall be taken from Table 4.

**Table 4 — Duration of test for filters and eye-protectors against laser radiation**

Test conditions for laser type	Typical laser type	Pulse length s	Minimum number of pulses
D	Continuous wave laser	5	1
I	Pulsed laser	$> 10^{-6}$ to 0,25	50
R	Q switch pulsed laser	$> 10^{-9}$ to $10^{-6}$	50
M	Mode-coupled pulse laser	$< 10^{-9}$	50

NOTE The pulse lengths for test conditions I and R do not follow consecutively. Neither are they a continuation of the length for test condition D. The pulse lengths indicated are characteristic values of typical lasers. It is recommended to use a laser with a pulse length in this range.

Testing shall be done at least for 5 s, but in the case of pulsed operation never with less than 50 pulses.