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Zaslони pri delu z laserji - Varovalne zahteve in preskušanje

Screens for laser working places - Safety requirements and testing

Abschirmungen an Laserarbeitsplätzen - Sicherheitstechnische Anforderungen und Prüfung

Ecrans pour postes de travail au laser - Exigences et essais de sécurité

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EUROPEAN STANDARD

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Screens for laser working places - Safety requirements and testing

Écrans pour postes de travail au laser - Exigences et essais de sécurité

Abschirmungen an Laserarbeitsplätzen - Sicherheitstechnische Anforderungen und Prüfung

This European Standard was approved by CEN on 20 February 2010.

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Foreword

This document (EN 12254:2010) 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of an identical text or by endorsement, at the latest by September 2010, and conflicting national standards shall be withdrawn at the latest by September 2010.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 12254:1998+A2:2008.

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 EC Directive(s).

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

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EN 12254:2010 (E)**1 Scope**

This European Standard specifies functional requirements and a product labelling applicable to temporary and permanent passive guards (in the following called screens) for protection against laser radiation. This standard includes test methods for testing functional performance and the specification of the user documentation to be supplied with the product. The screens are designed to protect the user from:

- unintentional exposure to direct and/or diffuse laser radiation;
- a time limited exposure to laser radiation, based on the functional requirements determined by risk assessment.

This European Standard applies to supervised screens for installations in working places at which laser radiation up to a maximum mean power of 100 W or single pulse energy of 30 J occurs within the spectral range between 180 nm (0,18 μm) and 10^6 nm (1 000 μm).

This European Standard applies to the protection against laser radiation only. This standard does not apply to other hazards including hazards from secondary radiation that can arise during, for example, material processing.

This European Standard gives guidance on how to select such screens.

Laser enclosures and housings that are supplied as part of the laser product or are supplied to be fitted to a laser system to form a laser product (according to EN 60825-1) are not considered to be within the scope of the standard.

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2 Normative references

SIST EN 12254:2010

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 165:2005, *Personal eye-protection — Vocabulary*

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

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

EN 1598:1997, *Health and safety in welding and allied processes — Transparent welding curtains, strips and screens for arc welding processes*

EN 1598:1997/A1:2001, *Health and safety in welding and allied processes — Transparent welding curtains, strips and screens for arc welding processes*

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

EN 60825-4:2006, *Safety of laser products — Part 4: Laser guards (IEC 60825-4:2006)*

IEC 60050-845:1987, *International Electrotechnical Vocabulary — Chapter 845: Lighting*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 165:2005, EN 60825-1:2007, EN 60825-4:2006 and IEC 60050-845:1987 apply.

4 Requirements

4.1 Spectral transmittance

The relationship between spectral transmittance at the laser wavelength and resistance to laser radiation is based on the maximum permissible exposure (MPE) shown in EN 60825-1. To simplify product specification, tests are conducted for laser test conditions described in Table 1. The laser test conditions are referred to by the symbols D, I, R and M.

Table 1 — Duration of test applicable to screens for laser working places

Test condition (corresponding laser designation)	Pulse duration s	Number of pulses
D (continuous wave (CW) laser)	100	1
I (pulsed laser)	10^{-6} to 10^{-2}	1 000
R (Giant pulsed laser)	10^{-9} to 10^{-6}	1 000
M (Mode-coupled pulsed laser)	$\leq 10^{-9}$	100 000

NOTE The listed pulse durations are values of typical lasers. A laser with a pulse length in this range of values is recommended for testing. Total exposure time for each test should be about 100 s.

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4.2 Resistance to laser radiation

The screens shall not lose their protective properties and shall stay within the scale number under effect of laser radiation with the power and energy density as specified in Table 2 including induced transmission (reversible bleaching).

4.3 Stability to UV radiation

When exposed to ultraviolet radiation in accordance with 5.4.1, the spectral transmittance at the laser wavelengths shall not exceed the maximum permissible spectral transmittance of the corresponding scale number.

4.4 Stability to elevated temperature

After exposure to elevated temperature in accordance with 5.4.2, the requirements of 4.1 to 4.2 shall be met.

4.5 Mechanical strength

Flexible screens shall withstand for 10 s a tensile stress of 15 N/mm^2 when tested according to 5.5.1. After this test, no sample shall be torn.

Inflexible screens shall be robust in accordance to 7.1.4.2 of EN 166:2001.

Fixing systems of screens shall be designed so that they remain attached to the screens or to the machinery when the screens are removed.

EN 12254:2010 (E)**4.6 Resistance to ignition**

Flexible screens shall satisfy the requirements of 4.4 of EN 1598:1997 when tested in accordance with 4.4 of EN 1598:1997 and EN 1598:1997/A1:2001.

Inflexible screens shall meet requirements according to 7.1.7 of EN 166:2001.

5 Testing**5.1 General**

The testing schedule in Table 3 applies to testing of flexible and inflexible screens. At least 18 samples are required for testing. If testing for several wavelengths (wavelength ranges) or testing conditions according to Tables 1 and 3 has to be done, more samples can be necessary.

5.2 Spectral transmittance

The spectral transmittance shall be determined at normal incidence. Screens with angular-dependent transmittance shall be measured at angles of incidence between 0° and 90° with polarised radiation. In this case, the scale number results from the highest of the spectral transmittance values measured.

5.3 Resistance to laser radiation

Testing shall be carried out with laser radiation of the specific wavelength(s) and the power and energy densities as indicated in Table 2. Spectral transmittance at the laser wavelength shall be measured during the exposure to laser radiation.

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**Table 2 — Scale numbers of screens for laser working places
(maximum spectral transmittance and resistance to laser radiation)**

Scale number	Maximum spectral transmittance at the laser wavelength $\tau(\lambda)$	Mean power (E) and single pulse energy density (H) for testing protective properties and resistance to laser radiation in the wavelength range										
		180 nm to 315 nm			> 315 nm to 1 050 nm	> 1 050 nm to 1 400 nm	> 315 nm to 1 400 nm			> 1 400 nm to 10 ⁶ nm		
		For test condition/pulse duration in s (see Table 1)										
		D	I, R	M	D	D	I, R	M	D	I, R	M	
		> 0,25	> 10 ⁻⁹ to 0,25	≤ 10 ⁻⁹	> 5·10 ⁻³	> 2·10 ⁻³	> 10 ⁻⁹ to 0,01	≤ 10 ⁻⁹	> 0,1	> 10 ⁻⁹ to 0,1	≤ 10 ⁻⁹	
		E_D W/m ²	$H_{I,R}$ J/m ²	E_M W/m ²	E_D W/m ²	E_D W/m ²	$H_{I,R}$ J/m ²	H_M J/m ²	E_D W/m ²	$H_{I,R}$ J/m ²	E_M W/m ²	
AB1	10 ⁻¹	0,01	3·10 ²	3·10 ¹¹	10	2,5·10 ²	0,05	0,0015	10 ⁴	10 ³	10 ¹²	
AB2	10 ⁻²	0,1	3·10 ³	3·10 ¹²	10 ²	2,5·10 ³	0,5	0,015	10 ⁵	10 ⁴	10 ¹³	
AB3	10 ⁻³	1	3·10 ⁴	3·10 ¹³	10 ³	2,5·10 ⁴	5	0,15	10 ⁶	10 ⁵	10 ¹⁴	
AB4	10 ⁻⁴	10	3·10 ⁵	3·10 ¹⁴	10 ⁴	2,5·10 ⁵	50	1,5	10 ⁷	10 ⁶	10 ¹⁵	
AB5	10 ⁻⁵	10 ²	3·10 ⁶	3·10 ¹⁵	10 ⁵	2,5·10 ⁶	5·10 ²	15	10 ⁸	10 ⁷	10 ¹⁶	
AB6	10 ⁻⁶	10 ³	3·10 ⁷	3·10 ¹⁶	10 ⁶	2,5·10 ⁷	5·10 ³	1,5·10 ²	10 ⁹	10 ⁸	10 ¹⁷	
AB7	10 ⁻⁷	10 ⁴	3·10 ⁸	3·10 ¹⁷	10 ⁷	2,5·10 ⁸	5·10 ⁴	1,5·10 ³	10 ¹⁰	10 ⁹	10 ¹⁸	
AB8	10 ⁻⁸	10 ⁵	3·10 ⁹	3·10 ¹⁸	10 ⁸	2,5·10 ⁹	5·10 ⁵	1,5·10 ⁴	10 ¹¹	10 ¹⁰	10 ¹⁹	
AB9	10 ⁻⁹	10 ⁶	3·10 ¹⁰	3·10 ¹⁹	10 ⁹	2,5·10 ¹⁰	5·10 ⁶	1,5·10 ⁵	10 ¹²	10 ¹¹	10 ²⁰	
AB10	10 ⁻¹⁰	10 ⁷	3·10 ¹¹	3·10 ²⁰	10 ¹⁰	2,5·10 ¹¹	5·10 ⁷	1,5·10 ⁶	10 ¹³	10 ¹²	10 ²¹	

The values of energy density (H) in Table 2 for testing the resistance against laser radiation for pulsed lasers (I, R, M) should be multiplied with the factor $N^{-1/4}$, where N is the number of pulses in 100 s.

For pulsed lasers, testing should be done with low repetition rates (≤ 25 Hz). If not possible, the energy density used for testing shall be given and the product shall be marked in accordance with Clause 6.

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

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

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.

All screens for laser radiation workplaces shall be tested in accordance with the test condition D. If commercially available, testing at mode D shall be done with a real cw laser. If it is not feasible, testing shall be done with a pulsed laser system at a minimum pulse repetition frequency of $f \geq 25$ Hz. If no laser with pulse repetition rates higher than 25 Hz is available, a pulsed laser system at a minimum pulse repetition frequency of $\nu \geq 5$ Hz may be used to test condition D.

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If additional protection against pulsed lasers is required, the screens shall be tested according to one or several of the test conditions I, R or M.

Only lasers that do not show spiking at the beginning of the emission shall be used. The spatial and temporal beam profile shall be documented, except for temporal profile of M mode lasers.

Table 3 — Test schedule for screens for protection against laser radiation

Order of testing	Requirement	According to Clause	Number of screen samples				
			3	3	6	3	3 or more
1	Marking	6	+	+	+	+	+
2	Spectral transmittance at laser wavelength λ	4.1	+	+			3 samples per λ and test condition
3	Stability to UV radiation	4.3		+			
4	Stability to elevated temperature	4.4	+				
5	Spectral transmittance at laser wavelength λ	4.3, 4.4	+	+			
6	Mechanical strength	4.5			+		+
7	Resistance to laser radiation and spectral transmittance at laser wavelength λ	4.2					3 samples per λ and test condition
8	Resistance to ignition	4.6				+	

5.4 Stability to UV radiation and stability at elevated temperature

5.4.1 Stability to UV radiation

Testing shall be done according to Clause 6 of EN 168:2001 with an exposure time of $(50 \pm 0,2)$ h.

5.4.2 Stability at elevated temperature

Screens shall be stored for at least 7 h in a climatic cabinet at a temperature of (55 ± 2) °C and a relative humidity of > 60 %, and then stored for at least 2 h at room temperature (23 ± 5) °C.

5.5 Mechanical strength

5.5.1 Flexible screens

5.5.1.1 Testing machine

The tensile testing machine shall be power-driven and capable of maintaining the appropriate rate of grip separation as specified in 5.5.1.3. The testing machine shall be equipped with the following devices.

— Grips for holding the test sample, one being fixed and the other movable.

The grips shall be self-aligning in that they are attached to the machine in such a way that they move freely into alignment as soon as any load is applied so that the long axis of the test sample coincides with the direction of pull through the centre line of the grip assembly. The test sample shall be held in such a way that slip relative to the grip is prevented as far as possible and this shall preferably be effected with the type of grip which maintains or increases pressure on the test sample as the force applied to the test sample increases. The clamping system shall not cause premature fracture at the grips.

- Load indicator incorporating a suitable load-indicating mechanism capable of showing the total tensile load carried by the test sample when held by the grips.

5.5.1.2 Test samples

Test samples 7 to 9 (10 mm wide and 150 mm long) are cut from the screen.

Test samples 10 to 12 (10 mm wide and 150 mm long) are cut from the screen, the longer dimension being perpendicular to the longer dimension of samples 7 to 9 when cutting them from the screen.

Determine the mean width and mean thickness of the test samples.

Gauge marks ($50,0 \pm 0,5$) mm apart shall be marked on the centre portion of the test samples using ink or other medium that does not affect the material being tested. Gauge marks shall not be punched, scratched or impressed upon the test samples.

Before testing for resistance to tear, the 6 samples shall be tested according to 5.4 for resistance to UV radiation. During this testing, at least the zone between the gauge marks shall be irradiated.

5.5.1.3 Procedure

Mount the test sample in the grips of the testing machine so that the axial alignment coincides with the direction of pull. Tighten the grips uniformly and firmly to prevent the sample from slipping, but not to the extent that the test sample is damaged.

Clamp the test sample so that the distance between the grips of the testing machine is (100 ± 1) mm and the gauge marks are centrally disposed between the grips.

Separate the grips of the testing machine with a speed of (250 ± 25) mm/min until a tensile stress of $(15,0 \pm 1,5)$ N/mm² is reached. 10 s after the maximum tensile stress has been reached, it is noted if any of the samples did tear.

Some materials have a very high elongation, which may bring them outside the stretching capacity of the testing machine. In such cases, it is permissible to reduce the initial distance between the grips to $(50 \pm 0,5)$ mm. The test with reduced distance shall be performed with a new sample.

5.5.2 Inflexible screens

Robustness shall be tested according to 3.1 of EN 168:2001.

5.5.3 Resistance to ignition

Testing of flexible screens shall be done in accordance with EN 1598:1997 and EN 1598:1997/A1:2001.

Testing of inflexible screens shall be done in accordance with Clause 7 of EN 168:2001.