

Safety of laser products —

Part 4: Laser guards

The European Standard EN 60825-4:1997, with the incorporation of amendments A1:2002 and A2:2003, has the status of a British Standard

ICS 31.260

National foreword

This British Standard is the English language version of EN 60825-4:1997, including amendments A1:2002 and A2:2003. It is identical with IEC 60825-4:1997, including amendments 1:2002 and 2:2003.

The UK participation in its preparation was entrusted to Technical Committee EPL/76, Optical radiation safety and laser equipment, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 February 1998

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(includes amendments A1:2002 and A2:2003)
(IEC 60825-4:1997 + A1:2002 and A2:2003)

Sécurité des appareils à laser —
Partie 4: Barrières laser
(inclut les amendements A1:2002 et A2:2003)
(CEI 60825-4:1997 + A1:2002 + A2:2003)

Sicherheit von Laser-Einrichtungen —
Teil 4: Laserschutzwände
(enthält Änderungen A1:2002 und A2:2003)
(IEC 60825-4:1997 + A1:2002 + A2:2003)

This European Standard was approved by CENELEC on 1997-10-01 and amendment A1 was approved by CENELEC on 2002-10-01 and amendment A2 was approved by CENELEC on 2003-10-01. CENELEC 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.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 76/159/FDIS, future edition 1 of IEC 60825-4, prepared by IEC TC 76, Optical radiation safety and laser equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60825-4 on 1997-10-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-08-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-08-01

For products which have complied with the relevant national standard before 1998-08-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2003-08-01.

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard, Annex ZA is normative and Annex A, Annex B and Annex C are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60825-4:1997 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of document 76/242/FDIS, future amendment 1 to IEC 60825-4:1997, prepared by IEC TC 76, Optical radiation safety and laser equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60825-4:1997 on 2002-10-01.

Annexes designated “normative” are part of the body of the standard. In this standard, Annex D is normative.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2003-07-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2005-10-01

Endorsement notice

The text of amendment 1:2002 to the International Standard IEC 60825-4:1997 was approved by CENELEC as an amendment to the European Standard without any modification.

Foreword to amendment A2

The text of document 76/263/FDIS, future amendment 2 to IEC 60825-4:1997, prepared by IEC TC 76, Optical radiation safety and laser equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A2 to EN 60825-4:1997 on 2003-10-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2004-07-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2006-10-01

This European Standard was prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and supports the essential requirements of Directive 1999/5/EC.

Annexes designated “informative” are given for information only.

In this standard, Annex E is informative.

Endorsement notice

The text of amendment 2:2003 to the International Standard IEC 60825-4:1997 was approved by CENELEC as an amendment to the European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

ISO 10218 NOTE Harmonized as EN 775:1992 (modified).

Contents

Foreword	
Introduction	
1 General	
1.1 Scope	
1.2 Normative references	
1.3 Definitions	
2 Laser processing machines	
2.1 Design requirements	
2.2 Performance requirements	
2.3 Validation	
2.4 User information	
3 Proprietary laser guards	
3.1 Design requirements	
3.2 Performance requirements	
3.3 Specification requirements	
3.4 Test requirements	
3.5 Labelling requirements	
3.6 User information	
Annex A (informative) General guidance on the design and selection of laser guards	
Annex B (informative) Assessment of foreseeable exposure limits	10
Annex C (informative) Elaboration of defined terms	17
Annex D (normative) Proprietary laser guard testing	19
Annex E (informative) Guidelines on the arrangement and installation of laser guards	20
Annex ZA (normative) Normative references to international publications with their corresponding European publications	28
Bibliography	29

Introduction

Page	At low levels of irradiance or radiant exposure, the selection of material and thickness for shielding against laser radiation is determined primarily by a need to provide sufficient optical attenuation.
2	
3	However, at higher levels, an additional consideration is the ability of the laser radiation to remove guard material – typically by melting, oxidation or ablation; processes that could lead to laser radiation penetrating a normally opaque material.
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6	IEC 60825-1 deals with basic issues concerning laser guards, including human access, interlocking and labelling, and gives general guidance on the design of protective housings and enclosures for high-power lasers.
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6	This part of IEC 60825 deals with protection against laser radiation only. Hazards from secondary radiation that may arise during material processing are not addressed.
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8	Laser guards may also comply with standards for laser protective eyewear, but such compliance is not necessarily sufficient to satisfy the requirements of this standard.
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9	Where the term “irradiance” is used, the expression “irradiance or radiant exposure, as appropriate” is implied.

1 General

1.1 Scope

This part of IEC 60825 specifies the requirements for laser guards, permanent and temporary (for example for service), that enclose the process zone of a laser processing machine, and specifications for proprietary laser guards.

This standard applies to all component parts of a guard including clear (visibly transmitting) screens and viewing windows, panels, laser curtains and walls. Requirements for beam path components, beam stops and those other parts of a protective housing of a laser product which do not enclose the process zone are contained in IEC 60825-1.

In addition this part of IEC 60825 indicates:

- a) how to assess and specify the protective properties of a laser guard; and
- b) how to select a laser guard.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60825. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60825 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60825-1:1993, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*.

ISO/TR 12100-1:1992, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*.

ISO/TR 12100-2:1992, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*.

ISO 11553:1996, *Safety of machinery — Laser processing machines — Safety requirements*.

1.3 Definitions

For the purpose of this part of IEC 60825, the following definitions apply in addition to the definitions given in IEC 60825-1.

1.3.1

active guard protection time

for a given laser exposure of the front surface of an active laser guard, the minimum time, measured from the issue of an active guard termination signal, for which the active laser guard can safely prevent laser radiation accessible at its rear surface from exceeding the class 1 AEL

1.3.2

active guard termination signal

the signal issued by an active guard in response to an excess exposure of its front surface to laser radiation and which is intended to lead to automatic termination of the laser radiation

NOTE The action of a safety interlock becoming open circuit is considered a "signal" in this context.

1.3.3

active laser guard

a laser guard which is part of a safety-related control system. The control system generates an active guard termination signal in response to the effect of laser radiation on the front surface of the laser guard

1.3.4

foreseeable exposure limit (FEL)

the maximum laser exposure on the front surface of the laser guard, within the maintenance inspection interval, assessed under normal and reasonably foreseeable fault conditions

1.3.5**front surface**

the face of the laser guard intended for exposure to laser radiation

1.3.6**laser guard**

a physical barrier which limits the extent of a danger zone by preventing laser radiation accessible at its rear surface from exceeding the class 1 AEL

1.3.7**laser processing machine**

a machine which uses a laser to process materials and is within the scope of ISO 11553

1.3.8**laser termination time**

the maximum time taken, from generation of an active guard termination signal, for the laser radiation to be terminated

NOTE Laser termination time does not refer to the response of an active laser guard but to the response of the laser processing machine, in particular the laser safety shutter.

1.3.9**maintenance inspection interval**

the time between successive safety maintenance inspections of a laser guard

1.3.10**passive laser guard**

a laser guard which relies for its operation on its physical properties only

1.3.11**process zone**

the zone where the laser beam interacts with the material to be processed

1.3.12**proprietary laser guard**

a passive or active laser guard, offered by its manufacturer as a guard with a specified protective exposure limit

1.3.13**protective exposure limit (PEL)**

the maximum laser exposure of the front surface of a laser guard which is specified to prevent laser radiation accessible at its rear surface from exceeding the class 1 AEL

NOTE 1 In practice, there may be more than one maximum exposure.

NOTE 2 Different PELs may be assigned to different regions of a laser guard if these regions are clearly identifiable (for example a viewing window forming an integral part of a laser guard).

1.3.14**rear surface**

any surface of a laser guard that is remote from the associated laser radiation and usually accessible to the user

1.3.15**reasonably foreseeable**

an event (or condition) when it is credible and its likelihood of occurrence (or existence) cannot be disregarded

1.3.16**safety maintenance inspection**

documented inspection performed in accordance with manufacturer's instructions

1.3.17**temporary laser guard**

a substitute or supplementary active or passive laser guard intended to limit the extent of the danger zone during some service operations of the laser processing machine

2 Laser processing machines

This clause specifies the requirements for laser guards that enclose the process zone and are supplied by the laser processing machine manufacturer.

2.1 Design requirements

A laser guard shall satisfy ISO/TR 12100-2 with respect to the general requirements for guards and also the more specific requirements with regard to its location and method of fixture. In addition, the following specific laser requirements shall be met.

2.1.1 General requirements

A laser guard, in its intended location, shall not give rise to any associated hazard at or beyond its rear surface when exposed to laser radiation up to the foreseeable exposure limit.

NOTE 1 Examples of associated hazards include: high temperature, the release of toxic materials, fire, explosion, electricity.

NOTE 2 See Annex B for assessment of foreseeable exposure limit.

2.1.2 Consumable parts of laser guards

Provision shall be made for the replacement of parts of a laser guard prone to damage by laser radiation.

NOTE An example of such a part would be a sacrificial or interchangeable screen.

2.2 Performance requirements

2.2.1 General

When the front surface of a laser guard is subjected to exposure to laser radiation at the foreseeable exposure limit, the laser guard shall prevent laser radiation accessible at its rear surface from exceeding the class 1 AEL at any time over the period of the maintenance inspection interval. For automated laser processing machines, the minimum value of the maintenance inspection interval shall be 8 h.

This requirement shall be satisfied over the intended lifetime of the laser guard under expected conditions of operation.

NOTE 1 This requirement implies both low transmission of laser radiation and resistance to laser-induced damage.

NOTE 2 Some materials may lose their protective properties due to ageing, exposure to ultraviolet radiation, certain gases, temperature, humidity and other environmental conditions. Additionally, some materials will transmit laser radiation under high-intensity laser exposure, even though there may be no visible damage (i.e. reversible bleaching).

2.2.2 Active laser guards

- a) The active guard protection time shall exceed the laser termination time up to the foreseeable exposure limits.
- b) The generation of an active guard termination signal shall give rise to a visible or audible warning. A manual reset is required before laser emission can recommence.

NOTE See Clause C.2 for an elaboration of terms.

2.3 Validation

If the laser processing machine manufacturer chooses to make a laser guard, the manufacturer shall confirm that the guard complies with the design requirements of 2.1 and can satisfy the performance requirements set out in 2.2.

NOTE See Annex A for guidance on the design and selection of laser guards.

2.3.1 Validation of performance

2.3.1.1 The complete laser guard, or an appropriate sample of the material of construction of the laser guard, shall be tested at each FEL identified.

NOTE 1 A table of predetermined PELs for common combinations of lasers and guarding materials, together with suitable testing procedures shall be issued as an informative annex in a future amendment to this standard. This could provide a simple alternative to direct testing for the majority of cases.

NOTE 2 See Annex B for the assessment of FEL.

2.3.1.2 For testing purposes, the FEL exposure shall be achieved either:

- a) by calculating or measuring the exposure and reproducing the conditions; or
- b) without quantifying the FEL, by creating the machine conditions under which the FEL is produced.

The condition of the laser guard or sample shall be such as to replicate those physical conditions of the front surface permitted within the scope of the routine inspection instructions and within the service life of the guard, which minimize the laser radiation protective properties of the laser guard (for example wear and tear and surface contamination) (see **2.4.2**).

2.4 User information

2.4.1 The manufacturer shall document and provide to the user the maintenance inspection interval for the laser guard, and details of inspection and test procedures, cleaning, replacement or repair of damaged parts, together with any restrictions of use.

2.4.2 The manufacturer shall document and provide to the user instructions that after any actuation of the safety control system of an active guard, the cause shall be investigated, checks shall be made for damage, and the necessary remedial action to be taken before resetting the control system.

3 Proprietary laser guards

This clause specifies the requirements to be satisfied by suppliers of proprietary laser guards.

3.1 Design requirements

A proprietary laser guard shall not create any associated hazard at or beyond its rear surface when exposed to laser radiation up to the specified PEL when used as specified in the user information (see **3.6**).

3.2 Performance requirements

The accessible laser radiation at the rear surface of the laser guard shall not exceed the class 1 AEL when its front surface is subjected to laser radiation at the specified PEL. For an active laser guard, this requirement shall apply to laser radiation accessible over the period of the active guard protection time, measured from the moment an active guard termination signal is issued.

This requirement shall be satisfied over the intended lifetime of the guard under expected service conditions.

3.3 Specification requirements

The full specification of a PEL shall include the following information:

- a) the magnitude and variation with time of irradiance or radiant exposure at the front surface of the laser guard (in units of Wm^{-2} or Jm^{-2} respectively), specifying any upper limit to the area of exposure;
- b) the overall duration of exposure under these conditions;
- c) the wavelength for which this PEL applies;
- d) the angle of incidence and (if relevant) the polarization of the incident laser radiation;
- e) any minimum dimensions to the irradiated area (for example as might apply to an active laser guard with discrete sensor elements so that a small diameter laser beam could pass through the guard undetected);
- f) for an active laser guard, the active guard protection time.

NOTE 1 See Clause **B.1** for an elaboration of terms.

NOTE 2 In all cases, a range or set of values can be stated rather than a single value.

NOTE 3 A graphical form of presentation (for example irradiance vs. duration with all other parameters constant).

3.4 Test requirements

3.4.1 General

Testing shall be performed using the complete laser guard or an appropriate sample of the material used to construct the guard. In either case, the condition of the guard or sample shall be such as to replicate or exceed the worst permissible physical condition of the front surface, including reduced surface reflection and damage permitted within the scope of the routine maintenance instructions (see 3.6).

The front surface irradiation shall be either as specified by the PEL or, in the case of sample testing, as specified in 3.4.2 below.

When the front surface is subjected to the PEL exposure conditions, the accessible laser radiation measured at the rear surface of the laser guard shall not exceed the class 1 AEL (tests as prescribed in Clause 8 of 60825-1). This requirement applies over the exposure duration specified in the PEL or, in the case of an active guard, over the specified active guard protection time measured from the moment an active guard termination signal is issued.

NOTE In cases where materials opaque at the laser wavelength(s) are used (for example metals), the transmitted radiation will only rise to the class 1 AEL when complete (or almost complete) physical removal of material along a path through to the rear surface has been achieved. In such cases, the rise from zero transmission to a value greatly in excess of the class 1 AEL will therefore be rapid, and sensitive radiation detectors will not be required.

3.4.2 Sample testing

Sample guard testing shall be performed by irradiating the front surface of the guard material using the procedure and methodology as specified in Annex D.

3.5 Labelling requirements

3.5.1 All labelling shall be placed on the rear surface of the guard.

3.5.2 The rear surface of the guard shall be clearly identified if the orientation of the guard is important.

3.5.3 If only part of the front surface of the guard is a laser guard, this area shall be clearly identified by a bold coloured outline and words to indicate the outer boundary of the laser guard.

3.5.4 The labelling shall state the full PEL specification.

3.5.5 The manufacturer's name, the date and place of manufacture according to ISO 11553, and a statement of compliance with this standard shall be provided.

3.6 User information

In addition to the specifications listed in 3.3, the following information shall be supplied to the user by the manufacturer of a proprietary laser guard:

- a) a description of the permitted uses of the laser guard;
- b) a description of the form of mounting and connection of the laser guard;
- c) information on the installation of the laser guard — for active laser guards this shall include interface and supply requirements for the guard;
- d) maintenance requirements, including for example details of inspection and test procedures, cleaning, replacement or repair of damaged parts;
- e) instructions, that after any actuation of the safety control system of an active guard, the cause shall be investigated, checks shall be made for damage, and the necessary remedial action to be taken before resetting the control system;
- f) the labels in 3.5 and their locations. If only part of the front surface of the guard is a laser guard, this area shall be identified;
- g) a statement of compliance with this standard.