SLOVENSKI STANDARD

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januar 2004

(istoveten EN 60825-1:1994/A1:2002)

Safety of laser products - Part 1: Equipment classification, requirements and user's guide - Amendment A1 (IEC 60825-1:1993/A1:1997)

ICS 13.280; 31.260

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English version

Safety of laser products
Part 1: Equipment classification,
requirements
and user's guide
(IEC 60825-1:1993/A1:1997)

Sécurité des appareils à laser
Partie 1: Classification des matériels,
prescriptions et guide de l'utilisateur
(CEI 60825-1:1993/A1:1997)

Sicherheit von Laser-Einrichtungen
Teil 1: Klassifizierung von Anlagen,
Anforderungen und Benutzer-Richtlinien
(IEC 60825-1:1993/A1:1997)

This amendment A1 modifies the European Standard EN 60825-1:1994; it was approved by CENELEC on 2002-07-02. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment 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 Central Secretariat or to any CENELEC member.

This amendment exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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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 amendment 1:1997 to the International Standard IEC 60825-1:1993, prepared by IEC TC 76, Optical radiation safety and laser equipment, was approved by CENELEC as amendment A1 to EN 60825-1:1994 on 2002-07-02 without any modification.

This amendment A1 replaces amendment A11:1996 to EN 60825-1:1994.

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– latest date by which the national standards conflicting with the amendment have to be withdrawn	(dow)	2004-01-01

Endorsement notice

The text of amendment 1:1997 to the International Standard IEC 60825-1:1993 was approved by CENELEC as an amendment to the European Standard without any modification.

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Amendement 1

Sécurité des appareils à laser –

Partie 1:
Classification des matériels, prescriptions et guide de l'utilisateur

Amendment 1

Safety of laser products –

Part 1:
Equipement classification, requirements and user's guide

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FOREWORD

This amendment has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

The text of this amendment is based on the following documents:

FDIS	Report on voting
76/157/FDIS	76/165/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

Page 49

8.2 *Measurement of laser radiation for determining classification*

Add, at the end of the second paragraph of item c), the following text:

, with the exception of those cases covered by 8.2 f) and 8.2 h).

Replace, on page 51, the text of item f) by the following text:

f) For apparent sources subtending an angle, α (determined at a distance not less than 100 mm), of less than or equal to 1,5 mrad, and within the wavelength range from 400 nm to 1 400 nm, by measuring the radiant power (W) or radiant energy (J) detectable through a circular measurement aperture of 50 mm diameter (to simulate the collection by an optical instrument of a stationary laser beam).

NOTE – The angle α subtended by the apparent source is determined at the nearest point of human access, but not less than a free air distance of 100 mm. Any angular dimension that is greater than α_{max} shall be limited to α_{max}, and any angular dimension that is less than 1,5 mrad shall be limited to 1,5 mrad.

For other sources within the wavelength range from 302,5 nm to 4 000 nm, this aperture diameter applies for any angular subtense of the source.

In cases where, by virtue of engineering design, the closest point of human access is greater than a distance of 14 mm from the apparent source (e.g. recessed source), the distance of the 50 mm aperture from the apparent source shall be 7,14 times the distance from the apparent source to the closest point of human access (to simulate a 7 mm aperture placed at the closest point of human access). However, the distance of the 50 mm aperture from the closest point of human access shall not be more than 2 m.

To eliminate collection of errant scattered radiation, for collimated beams having a divergence less than 5 mrad, the 50 mm aperture shall be placed at a distance of 2 m from the beam exit aperture.

Replace, on page 51, the first paragraph of item h) by the following text:

h) For apparent sources subtending an angle, α (determined at a distance not less than 100 mm; (see note in f) above), greater than 1,5 mrad and within the wavelength range from 400 nm to 1 400 nm, by measuring the radiant power (W) or radiant energy (J) detectable through a circular measurement aperture of 7 mm diameter positioned at a distance r from the source, depending upon the angular subtense α (between a minimum of 1,5 mrad and a maximum of α_{max} = 100 mrad) of the source.

The distance *r* of the 7 mm measurement aperture from the apparent source is determined by:

$$r = 100\sqrt{\frac{\alpha + 0{,}46 \text{ mrad}}{\alpha_{max}}} \text{ mm}$$

In cases where, by virtue of engineering design, the measurement aperture cannot be placed at a distance *r* (e.g., recessed source), the minimum measurement distance shall be at the closest point of human access.

Alternatively, if a 7 mm aperture could be placed within a distance *r* from the apparent source, measurements can be made with a circular aperture having a diameter *d* between 7 mm and 50 mm depending upon the angular subtense α (between a minimum of 1,5 mrad and a maximum of α_{max} = 100 mrad) of the source. This aperture shall be placed at a distance of 100 mm from the apparent source.

The diameter d of the measurement aperture is determined by:

$$d = 7\sqrt{\frac{\alpha_{max}}{\alpha + 0{,}46 \text{ mrad}}} \text{ mm}$$

Replace, on page 51, the last paragraph of item h) by the following text:

For the determination of the AEL, the value of the angular subtense of a rectangular or linear source is determined by the arithmetic mean of the two angular dimensions of the source. Any angular dimension that is greater than α_{max} or less than 1,5 mrad should be limited to α_{max} or 1,5 mrad respectively, prior to determining the mean.

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9.3 *Classification procedures*

Replace, on page 55, the text of item e) by the following text:

e) Time basis

The following time bases are used in this standard:

1) 0,25 s for class 2 and class 3A laser radiation within the wavelength range from 400 nm to 700 nm as determined by tables 2 and 3, respectively;

2) 100 s for laser radiation of all wavelengths greater than 400 nm except for the cases listed in a) and c);

3) 30 000 s for laser radiation of all wavelengths less than or equal to 400 nm, and for laser radiation of wavelengths greater than 400 nm where intentional long-term viewing is inherent in the design or function of the laser product.

Page 91

Subclause 13.4.1

Insert, at the beginning of the second sentence before "In the wavelength range..." the following new text:

For ocular exposure

Page 93

Subclause 13.4.2

Replace the last paragraph by the following:

For the determination of the MPE, the value of the angular subtense of a rectangular or linear source is determined by the arithmetic mean of the two angular dimensions of the source. Any angular dimension that is greater than α_{max} or less than 1,5 mrad should be limited to α_{max} or 1,5 mrad respectively, prior to determining the mean.

Page 95

Table 6

Delete, in the title, the word "direct."

Page 115

Annex A – Examples of calculations

Replace, on page 125, the existing text of example A.2-4 by the following new text:

Find the MPE applicable to intrabeam viewing for a 10 s exposure at a distance of 1 m from a complex Ga-As (905 nm) laser diode array source. The source consists of two rows of 10 diodes each that are mounted behind collimating optics. The source has an output power of 6 W and a pulse repetition frequency *F* of 12 kHz. The pulse duration is 80 ns. The exit aperture (collimating lens) is 5 cm in diameter and the emergent beam diameter is 3,5 cm at the 1/e peak irradiance points (i.e., a 3,5 cm circular measurement aperture would collect 63 % of the beam power). The axial beam irradiance (average) at a distance of 1 m is $3,6 \times 10^3$ W · m^{-2}. The beam divergence is 25 mrad horizontally by 3 mrad vertically, and at a distance of 1 m from the exit aperture, the beam size is approximately 3,0 cm by 3,8 cm, respectively.

An intrabeam photograph (using infrared film) taken at a distance of 1 m from the exit aperture reveals that each diode subtends a projected line image 2,2 mrad long and less than 0,5 mrad across. Each diode is separated by an angle of 3,0 mrad centre-to-centre, and the two rows are separated by an angle of 2,3 mrad (see figure A.1). Using an infrared image converter with an OD 4 filter to reduce glare, it is revealed that these angular separations are constant from all viewing distances between 10 cm and 2 m (this behaviour is explained in chapter 15 of Sliney and Wolbarsht, *Safety with Lasers and other Optical Sources*, New York: Plenum Publishing Co., 1980).

Solution

The MPE applicable to the laser diode array is the most restrictive MPE resulting from an evaluation of each individual source and each possible grouping of the array of diodes. However, the evaluation can be greatly simplified by using the conservative assumption that all the radiant power originates from a single point source. This would always overstate the hazard, and if it did not result in overly restrictive control measures, one would not have to perform the more complex analysis of the extended source.

The determination of the applicable (most restrictive) MPE requires a trial-and-error approach, since the MPE for a single diode, two adjacent diodes, a group of three or four, etc., and the entire array is to be calculated; recognizing that in each case the power or energy is averaged over the angular subtense d applicable to that grouping. It is useful to draw a map of the source to study different combinations of diodes (see figure A.1). In addition to grouping, the applicable angular subtense differs depending upon whether the limiting case is the MPE of an individual pulse reduced by the repetitive pulse correction factor, C_5, in which case α_{min} = 1,5 mrad, or is the MPE for the train of pulses, in which case α_{min} = 11 mrad. The total number of pulses N in a 10 s exposure is 120 000.

The single pulse MPE for the multiple-pulse assessment is given by (using table 6 for an 80 ns pulse) the following:

$$H_{MPE,train} = C_5 \times 5 \times 10^{-3}\, C_4 C_6 \text{ J} \cdot \text{m}^{-2}$$

$$= 120\,000^{-0,25} \times 5 \times 10^{-3} \times 2,57\, C_6 \text{ J} \cdot \text{m}^{-2}$$

$$= 6,9 \times 10^{-4}\, C_6 \text{ J} \cdot \text{m}^{-2}$$

In order to compare the single pulse MPE with the average irradiance of the beam, it is convenient to express the above MPE (expressed in terms of radiant exposure) as an irradiance averaged over *F* pulses per second as follows:

$$E_{MPE,train,F} = H_{MPE,train} \times F$$

$$= 6,9 \times 10^{-4}\, C_6 \text{ J} \cdot \text{m}^{-2} \times 1,2 \times 10^4 \text{ Hz}$$

$$= 8,28\, C_6 \text{ W} \cdot \text{m}^{-2}$$

The single pulse MPE for the average power assessment is given by (using table 6 for a 10 s exposure) the following:

$$H_{MPE,avg} = 18 \times t^{0,75}\, C_4\, C_6 \text{ J} \cdot \text{m}^{-2}$$

$$= 18 \times 10^{0,75} \times 2,57\, C_6 \text{ J} \cdot \text{m}^{-2}$$

$$= 260 \times C_6 \text{ J m}^{-2}$$

The above MPE, expressed as a radiant exposure, can also be expressed as an irradiance averaged over the 10 s exposure as follows:

$$E_{MPE,avg} = H_{MPE,avg}/t$$

$$= 260 \times C_6 \text{ J} \cdot \text{m}^{-2} /(10 \text{ s})$$

$$= 26 \times C_6 \text{ W} \cdot \text{m}^{-2}$$