SLOVENSKI STANDARD
SIST EN 60825-1:2014/A11:2021

01-junij-2021

Varnost laserskih izdelkov - 1. del: Klasifikacija opreme in zahteve

Safety of laser products - Part 1: Equipment classification and requirements

Sicherheit von Lasereinrichtungen - Teil 1: Klassifizierung von Anlagen und Anforderungen

Sécurité des appareils à laser - Partie 1: Classification des matériels et exigences

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ICS:

13.280	Varstvo pred sevanjem	Radiation protection
31.260	Optoelektronika, laserska oprema	Optoelectronics. Laser equipment

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2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

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English Version

Safety of laser products - Part 1: Equipment classification and requirements

Sécurité des appareils à laser - Partie 1: Classification des matériels et exigences

Sicherheit von Lasereinrichtungen - Teil 1: Klassifizierung von Anlagen und Anforderungen

This amendment A11 modifies the European Standard EN 60825-1:2014; it was approved by CENELEC on 2021-01-18. 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.

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European Committee for Electrotechnical Standardization
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European foreword

This document (EN 60825-1:2014/A11:2021) has been prepared by CLC/TC 76 "Optical radiation safety and laser equipment".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2022-01-18
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2024-01-18

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

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

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This document is expected to be read in conjunction with EN 50689[1] 'Safety of laser products - Particular Requirements for Consumer Laser Products', when available.

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[1] Under preparation. Stage at the time of publication: prEN 50689:2019.

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1 Modifications to Clause 1, "1 Scope and object"

In Clause 1, replace the existing text:

"This Part 1 describes the minimum requirements. Compliance with this Part 1 may not be sufficient to achieve the required level of product safety. Laser products may also be required to conform to the applicable performance and testing requirements of other applicable product safety standards.

NOTE 3 Other standards may contain additional requirements. For example, a Class 3B or Class 4 laser product may not be suitable for use as a consumer product."

Where a laser system forms a part of equipment which is subject to another IEC product safety standard, e.g. for medical equipment (IEC 60601-2-22), IT equipment (IEC 60950 series), audio and video equipment (IEC 60065), audio-video and IT equipment (IEC 62368-1), equipment for use in hazardous atmospheres (IEC 60079), or electric toys (IEC 62115), this Part 1 will apply in accordance with the provisions of IEC Guide 104[2] for hazards resulting from laser radiation. If no product safety standard is applicable, then IEC 61010-1 may be applied."

with the following:

"This Part 1 describes requirements that are considered sufficient to achieve the required level of product safety for general laser products with respect to hazards to the eye and skin posed by laser radiation, provided that consumer laser products comply with EN 50689[1] (see 9.5 in EN 60825-1:2014/FprAA:2020). Also, as required in 5.3 b) of EN 60825-1, that laser products classified as Class 1C comply with the respective applicable part of either the EN 60601 series or the EN 60335 series that contains requirements for the safe exposure of the skin (note that the exposure of the skin is not necessarily limited to the MPE values of the skin), if applicable, as well as specific requirements for the performance and testing of the safeguard that prevents hazardous emission towards the eye. Depending on the type of the product, laser products such as for example medical lasers, machines or toys can be required to conform to the applicable performance and testing requirements of their relevant product safety standards.

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NOTE 3 See 3.92 for "general laser product".

Where a laser system forms a part of equipment which is subject to another IEC product safety standard, e.g. for medical equipment (IEC 60601-2-22), IT equipment (IEC 60950 series), audio and video equipment (IEC 60065), audio-video and IT equipment (IEC 62368-1), electrical equipment for measurement, control, and laboratory use (IEC 61010-1), equipment for use in hazardous atmospheres (IEC 60079), or electric toys (IEC 62115), this Part 1 will apply in accordance with the provisions of IEC Guide 104[2] for hazards resulting from laser radiation."

2 Additions to Clause 3, "Terms and definitions"

In Clause 3, add the following terms and their definitions:

"

3.91
consumer laser product
any product or assembly of components that:

(a) is intended for consumers, or likely to be used by consumers under reasonably foreseeable conditions even if not intended for them; and

(b) constitutes or incorporates a laser or laser system

[2] IEC Guide 104:2019, The preparation of safety publications and the use of basic safety publications and group safety publications

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3.92
general laser product
laser product that does not fall within the scope of another EN standard that addresses the safety of a specific category of laser products

Note 1 to entry: Examples of products where such other EN Standards exist are medical lasers (EN 60601-2-22), electric toys (EN 62115) or laser processing machines (EN ISO 11553-1, EN ISO 11553-2).

Note 2 to entry: General laser products are for instance laboratory equipment, laser products for measurements, laser pointers, display lasers and laser illuminated projectors.

Note 3 to entry: EN 50689[1] is not considered as another EN standard that addresses the safety of a specific category of laser products, since it applies to all consumer laser products."

3 Modification to subclause 4.3, "Classification rules"

In Note 3 of 4.3 c), replace the following text:

"NOTE 3 A source is considered an extended source when the angular subtense of the source is greater than α_{min}, where α_{min} = 1,5 mrad. Most laser sources have an angular subtense α less than α_{min}, and appear as an apparent "point source" (small source) when viewed from within the beam (intra-beam viewing). Indeed a circular laser beam cannot be collimated to a divergence less than 1,5 mrad if it is an extended source, thus any laser where a beam divergence of 1,5 mrad or less is specified cannot be treated as an extended source. For a small source, α is set to α_{min} = 1,5 mrad and C_6 = 1."

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with:

"NOTE 3 An apparent source is considered an extended source when the angular subtense of the apparent source (i.e. the angular subtense of the image of the source) is greater than α_{min}, where α_{min} = 1,5 mrad (note that different accommodation states as well as different positions in the beam have to be considered for the classification of extended sources). Most laser sources have an angular subtense α less than α_{min}, and appear as an apparent "point source" (small source) when viewed from within the beam (intra-beam viewing). Indeed, if a laser beam is to qualify as an extended source, it cannot be collimated to a divergence less than 1,5 mrad unless it is astigmatic (i.e. could be collimated in one dimension only) or scanning. Thus any non-scanning circularly symmetric laser beam, where a beam divergence of 1,5 mrad or less is specified, cannot be treated as an extended source, since accommodation to infinity for intrabeam viewing of such a source produces a retinal image that subtends an angle of less than 1,5 mrad. Also, more generally, any circular, non-scanning high quality Gaussian beam (TEM_{00}) with a beam quality factor M^2 equal or close to unity is associated to a small apparent source, as either the beam waist subtends an angular subtense smaller than 1,5 mrad or the divergence is smaller than 1,5 mrad. For a small source, α is set to α_{min} = 1,5 mrad and C_6 = 1. See also definitions 3.7, 3.10, 3.36, 3.42. A frequent mistake is to associate the beam diameter, or the beam profile, at the laser aperture with the apparent source; the laser aperture as such has no special distinctiveness that is related to the apparent source. Examples of designs that might constitute an extended source are: transmissions through a diffusor, transmissions through a diffractive optical element (DOE), partially coherent beams (i.e. beams with low beam quality and therefore higher values of the beam quality factor M^2), scanned emission, fibres, and astigmatic beams (since the eye cannot accommodate to both waists at the same time). Measurements of the image of the apparent source are expected to be performed with sufficient accuracy, typically with a laser beam profiler CCD camera. As an alternative to characterizing the angular subtense of the apparent source (note that different accommodation states are expected to be considered, as well as different positions in the beam, see 5.4.3), C_6 can be set to unity (simplified evaluation, see 5.4.2)."

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4 Modifications to subclause 5.3, “Determination of the class of the laser product”

In subclause 5.3, replace the existing text of footnote d of Table 3, footnote f of Table 4, footnote d of Table 6 and footnote c of Table 7:

“In the wavelength range between 1 250 nm and 1 400 nm, the upper value of the AEL is limited to the AEL value for Class 3B.”

with:

“In the wavelength range between 1 250 nm and 1 400 nm, two additional limitations apply.

The value of the AEL in the table above is limited to the AEL value for Class 3B.

The accessible emission, determined with the specified aperture stop, is limited by the following values (these limits are derived from the MPE of the skin and are required as an additional limit to protect the anterior parts of the eye). This limitation for the eye is to be treated as additive with the spectral region of 1400 nm to 10^6 nm listed in Table 1.

For $t < 10^{-9}$ s:	$7{,}9 \times 10^5$ W	Aperture stop diameter: 1 mm
For 10^{-9} s $\leq t < 10^{-7}$ s:	$7{,}9 \times 10^{-4}$ J	Aperture stop diameter: 1 mm
For 10^{-7} s $\leq t <$ 0,35 s:	$4{,}3 \times 10^{-2}\ t^{0{,}25}$ J	Aperture stop diameter: 1 mm
For $t \geq$ 0,35 s:	0,1 W	Aperture stop diameter: 0,35 s $\leq t <$ 10 s: 1,5 $t^{3/8}$ mm $t \geq$ 10 s: 3,5 mm

”

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5 Modification to subclause 6.2.1, “General”

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In 6.2.1, replace the existing first paragraph:

“Each laser product shall have a protective housing which, when in place, prevents human access to laser radiation (including errant laser radiation) in excess of the AEL for Class 1, except when human access is necessary for the performance of the function(s) of the product.”

with:

“Each laser product shall have a protective housing which, when in place, prevents human access to laser radiation (including errant laser radiation) in excess of the AEL for Class 1, unless human access to laser radiation is necessary for the performance of the function(s) of the product. Where human access to radiation levels above the AEL for Class 1 is necessary, the product shall be in the lowest feasible class commensurate with this function.

NOTE Where such human access is necessary only at certain times and not during routine operation of the product (e.g. to allow specific maintenance procedures, which are described in the information for the user, to be undertaken by the user) the protective housing prevents human access to laser radiation in excess of the AEL for Class 1 during routine operation. This requirement for a protective housing does not mean that the product needs to meet all the requirements for, and to be classified as, Class 1. This is because classification as Class 1 cannot be achieved when access to levels of laser radiation of Class 3B or Class 4 is necessary during maintenance procedures.”

6 Modification to subclause 9.5, “Consumer electronic products”

Replace the entire text of subclause 9.5 with the following:

“Consumer laser products shall comply with applicable requirements for laser products of their class as well as with EN 50689[1]. In addition, these products may be subject to specific safety standards such as

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EN 62368-1 (AV/ICT equipment). Products that are classified as Class 1C need to comply with the requirements of the respective specific vertical standard of the EN 60335 series or the EN 60601 series.

NOTE EN 50689[1] will be made available after the publication of EN 60825-1:2014/FprAA:2020. In the period of time until EN 50689[1] is published, there are no specific requirements for consumer products. It is noted that some EU member states have issued guidance documents and/or legal requirements that apply to consumer laser products and that are not harmonized amongst EU member states."

7 Addition of Annex ZB, "Information for the Interpretation of 4.3, 4.4 and 6.3.2"

Add the following Annex ZB:

"

Annex ZB
(informative)

Information for the Interpretation of 4.3, 4.4 and 6.3.2

ZB.1 General remarks

This informative annex is added to EN 60825-1:2014 in order to publish the content of the IEC Interpretation Sheets IEC 60825-1:2014/ISH1:2017 and IEC 60825-1:2014/ISH2:2017 by CENELEC. The content is published as an annex to EN 60825-1, because the publication type "Interpretation Sheet" is not available at CENELEC level. Because there are no page-number limitations for an annex (contrary to an Interpretation Sheet), the text of the IEC ISH1 and ISH 2 has been somewhat extended in order to increase the readability and clarity.

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ZB.2 Subclause 4.3 Classification rules (IEC 60825-1:2014/ISH1:2017)

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ZB.2.1 General remarks

This subclause ZB.2 contains the text of ISH1; some examples were added for clarity.

For some complex extended sources or irregular temporal emissions, the application of the rules of 4.3 may require clarification.

In this subclause ZB.2, 4.3 (Classification rules) is clarified.

NOTE 1 For the purpose of this annex, the abbreviation "AE" is used for "accessible emission".

NOTE 2 The clarifications also apply in an equivalent way to MPE analysis, i.e. for Annex A.

ZB.2.2 Subclause 4.3 c) (Radiation from extended sources)

When using the default (simplified) evaluation method (5.4.2) for wavelengths ≥ 400 nm and < 1 400 nm, the angle of acceptance may be limited to 100 mrad for determining the accessible emission to be compared against the accessible emission limit, except in the wavelength range 400 nm – 600 nm for durations longer than 100 s where the circular-cone angle of acceptance is not limited. When evaluating the emissions for comparison to the Class 3B AELs, the angle of acceptance is not limited.

ZB.2.3 Subclause 4.3 d) (Non-uniform, non-circular or multiple apparent sources)

In 4.3 d), for comparison with the thermal retinal limits, the requirement to vary the angle of acceptance in each dimension might appear to contradict the labelling in Figure 1 and Figure 2 of 5.4.3 where the field stop is labelled as circular.

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Interpretation

A circular field stop is applicable for circularly symmetric images of the apparent source and for this case is consistent with the procedure given in 4.3 d). For images of the apparent source that are not circularly symmetric, the simple example below clarifies the application of 4.3 d).

A circular field stop with an angular subtense equal to α_{max} is, however, applicable for non-circularly symmetric profiles if the analysis performed according to 4.3 d), following variation of the angle of acceptance in each dimension, results in a solution which is equal to α_{max} in both dimensions.

As a general principle, for whatever emission duration t that is used to determine the AEL (such as the pulse duration, the pulse group duration or the time base for averaging of the power), the same emission duration t is also used to calculate $\alpha_{max}(t)$.

The following example demonstrates the method described in 4.3 d) to analyse irregular or complex images of a source. It is noted that the example is equivalent to the second part of the example ("Additional Remarks"; 6 mrad spacing instead of 3 mrad) B.9.1 of IEC/TR 60825-14:2004 (however, for 6 mrad element spacing, the result in terms of which grouping is critical was not correct in IEC/TR 60825-14:2004). The source is a diode array (Figure ZB.1). The task is to determine the applicable AEL that limits the AE for Class 2. Each diode contributes a partial accessible emission AE of 1 mW that passes through a 7 mm aperture stop at the distance where the analysis is performed (i.e. a total power of 20 mW passes through the aperture stop), and the emission is continuous wave. The analysis requires determination of the most restrictive (maximum) ratio of AE over AEL by variation of the angle of acceptance in position and size to achieve different field of views.

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Figure ZB.1 — Retinal image of a source pattern for the example of 20 emitters. Two possible groupings are defined by the respective angle of acceptance γ_x and γ_y

The analysis of a sub-group of sources is associated with a certain value of α for that group, and a certain accessible emission associated with that sub-group. For instance, α of a single element equals (2,2 mrad + 1,5 mrad)/2 = 1,85 mrad so that C_6 = 1,85/1,5 = 1,23 and therefore the AEL = 1,23 mW. The applicable AE = 1 mW and AE/AEL = 1 mW/1,23 mW = 0,81. For a vertical two-element group, as shown in Figure ZB.1 with γ_{x1} and γ_{y1}, α = (2,2 mrad + 2,8 mrad)/2 = 2,5 mrad so that C_6 = 2,5/1,5 = 1,67 and therefore AEL = 1,67 mW; AE = 2 × 1 mW = 2 mW and AE/AEL = 1,2, which is more restrictive than AE/AEL for only one element. For one row of 10 diodes α = (56,2 mrad + 1,5 mrad)/2 = 28,9 mrad, C_6 = 28,9/1,5 = 19,2 and therefore the AEL = 19,2 mW, the AE = 10 × 1 mW = 10 mW and AE/AEL = 0,5. Analysis of all possible groupings shows that the vertical two-element group has the maximum AE/AEL and therefore is the solution of the analysis. This means that the AEL of Class 2 is exceeded by a factor 1,2. Note that only a portion of the power of 20 mW that passes through the 7 mm aperture stop is considered as the AE (2 mW; as partial power within the angle of acceptance that is associated to the part of the image with the maximum ratio of AE/AEL) that is compared against the AEL. The entire array represents the highest ratio of AE/AEL in cases where the element spacing is sufficiently close, e.g. when the contributions of added elements to the AE are not sufficiently compensated by the increased AEL due to the larger subtended angle.

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For pulsed emission, for the determination of α according to the above method (4.3. d)) where the ratio of AE to AEL is maximized, requirement 3) of 4.3. f) is not applied, i.e. the AEL_{single} is not reduced by C_5 when the value of α is determined; however, C_5 *is* applied to AEL_{single} for the classification of the product.

Due to the dependence of α_{max} on emission duration t, the analysis of the image of the apparent source may result in different values of α and of the partial accessible emission, depending which emission duration is analysed for the requirements of 4.3 f). For example in Figure ZB.1, for emission durations shorter than 625 µs (α_{max} = 5 mrad), the maximum partial array to consider in the image analysis is a vertical two element group.

Ref.: Schulmeister K, Classification of extended source products according to IEC 60825-1, ILSC 2015 Proceedings Paper, Laser Institute of America, Orlando, pp. 271 – 280

It is important to note the overall methodology for this “image” analysis: a varying field of view is used and for each, the partial AE is determined, as well as the value of α associated to that field of view (setting $\alpha_v = \gamma_v$ and $\alpha_h = \gamma_h$); the respective value of α then determines the value of the AEL. For the variation of the angle of acceptance, the limits of α_{min} and α_{max} apply to the extent of the angle of acceptance in each dimension. It might also be necessary to rotate the image for the application of rectangular field of views. The solution of the analysis is *that* field of view which is associated to the maximum ratio of AE/AEL. The angular subtense of the “critical” field of view is then used to determine C_6, and the critical field of view is also used to determine the AE. Therefore, when the image of the apparent source is larger than the critical field of view, the AE is smaller than the total radiation that passes through the 7 mm aperture stop.

The fact that the whole array in this example gives an AE/AEL factor smaller than the factor of the two-diode group does not mean that the whole array, i.e. the assembly of 20 diodes, is less “hazardous” than the two-diode group. If an injury would occur from exposure to radiation from the array, the injury would still be made up by the 20 elements. The meaning of this apparently strange result is that, in this specific case, the correct evaluation of the “hazard” is not obtained by considering the 20 diodes as one uniform source, but is given by the analysis of parts that form the array. This is due to the fact that the image of the apparent source is not uniform. If the elements would be spaced further apart also in vertical direction, the solution of the image analysis would be that one element is the critical one (associated to the maximum ratio of AE/AEL), which can also be understood in terms of thermal injury mechanism: when the retinal image elements are far enough apart, they represent thermally independent exposures.

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Caution should be exercised in the assessment of irregular image profiles of the apparent source. Where uncertainty may exist, it is best to over-state the region of collected partial power, and under-state the value of α used to determine the AEL.

Alternative simplified methods to analyse the apparent source are permissible if it can be demonstrated that they are no less restrictive than the method as defined in 4.3 d). The simplest and most restrictive approach is to use the accessible emission as determined with the aperture stop (see Table 10) and an open field of view (or restricted to α_{max}) and assume a small source where C_6 = 1. Another method is to neglect all parts of the image where the image irradiance is less than the 1/e value of the peak image irradiance and, using the smallest of the remaining image feature to determine α while considering the total power that passes through the aperture stop as accessible emission.

NOTE As a simplified method for the case that the irradiance profile of the image is Gaussian, according to definition 3.7 Note 1 to entry, the d_{63} beam diameter definition can be used to determine the value of α. In this case, it is not necessary to apply the analysis method defined in subclause 4.3 d) (i.e. variation of the angle of acceptance) but then the total power or energy that passes through the aperture stop and a circular field stop with an angular subtense equal to α_{max} is considered as the accessible emission.