IEC 60825-1

Edition 2.0 2007-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

GROUP SAFETY PUBLICATION
PUBLICATION GROUPÉE DE SÉCURITÉ

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

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

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub
The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.
- IEC Just Published: www.iec.ch/online_news/justpub
Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.
- Electropedia: www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.
- Customer Service Centre: www.iec.ch/webstore/custserv
If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm
Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.
- Just Published CEI: www.iec.ch/online_news/justpub
Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.
- Electropedia: www.electropedia.org
Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.
- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 60825-1

Edition 2.0 2007-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

GROUP SAFETY PUBLICATION
PUBLICATION GROUPÉE DE SÉCURITÉ

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

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX XD

ICS 13.110; 31.260

ISBN 2-8318-9085-3

Publication IEC 60825-1 (Second edition – 2007) I-SH 01

SAFETY OF LASER PRODUCTS –

Part 1: Equipment classification and requirements

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by committee 76: Optical radiation safety and laser equipment.

The text of this interpretation sheet is based on the following documents:

ISH	Report on voting
76/415/ISH	76/418/RVD

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

Subclauses 9.2 and 9.3

These subclauses are clarified by the following:

Introduction

For emissions in the wavelength range of 400 nm to 1 400 nm, the need to perform measurements for Condition 2 (eye loupe viewing) can be greatly reduced by recognising that Condition 3 (unaided viewing) in many cases will be the most restrictive criterion.

Interpretation

The following table outlines the process in this interpretation of IEC 60825-1, subclauses 9.2 and 9.3.

IF	THEN
Angular Subtense > 1,5 mrad @ 100 mm from the reference point	Condition 2 need not be considered
Angular Subtense ≤ 1,5 mrad @ 100 mm; or the angular subtense is not determined	Use simplified Condition 2, C_6 = 1
Optional for intermediate sources: Angular Subtense ≤ 1,5 mrad @ 100 mm AND > 1,5 mrad using Figure 5	CAN use Figure 5 (with C_6 determined using Figure 5) if simplified Condition 2 is too restrictive for the application

Rationale

Based on independent studies (see for instance reference [1]), it is found that for extended sources and for radiation in the wavelength range of 400 nm to 1 400 nm, Condition 3 will in most cases be more restrictive than Condition 2 for extended sources (Figure 5). The main reason for this is the magnification of the source obtained with Condition 2. Also, the aperture stop of Condition 2 is limited to 3,5 mm since it simulates a case where there is a high level of ambient lighting, while Condition 3 uses a 7 mm aperture stop, as it simulates a general viewing condition including accidental exposure.

Row *1 in the table above:*

If it can be shown that the apparent source is extended (α > 1,5 mrad) for unaided viewing at 100 mm distance from the reference point, Condition 2 does not have to be considered.

Row 2 in the table above:

If the source is not extended for unaided viewing (i.e. the angular subtense of the apparent source is less than 1,5 mrad at 100 mm distance from the reference point), or if the angular subtense of the apparent source is not determined (default simplified evaluation), Condition 2 needs to be considered, as it could be more restrictive than Condition 3.

Row 3 in the table above:

For the case that the optional application of Condition 2 for extended sources (Figure 5) is considered, the following cases can be distinguished:

a) if the angular subtense of the apparent source is determined to be less than 1,5 mrad at 100 mm from the reference point, but appears extended (α >1,5 mrad) using Condition 2 for extended sources (Figure 5) (due to the magnification of the eye loupe), Condition 2 for extended sources may be less restrictive than the simplified Condition 2 and can be applied for the test. If Condition 2 for extended sources (per Figure 5) is used, the corresponding angular subtense is also to be determined using this measurement setup. It should be noted that in this case Condition 3 (where C_6 =1) can be more restrictive than Condition 2 for extended sources (Figure 5) and has to be considered.

b) if the angular subtense of the apparent source is determined to be less than 1,5 mrad at 100 mm from the reference point, and is also less than 1,5 mrad using Condition 2 for extended sources (Figure 5), the simplified Condition 2 (Table 11) is applicable.

NOTE For the default (simplified) evaluation described in 9.3.2 of the standard, it is not necessary to determine the angular subtense of the apparent source. The apparent source can be assumed to be a small source to simplify the analysis, since this would be the most restrictive case. The simplified measurement conditions listed in Table 11 would apply (Row 2 in the table above).

References

[1] *Influence of magnifiers on ocular exposure levels*, G Vees, R Gilber and K Schulmeister, ILSC Paper 503, ILSC 2009 Proceedings (Laser Institute of America)

TC 76/Publication IEC 60825-1 (2007), second edition/I-SH 02

SAFETY OF LASER PRODUCTS –

Part 1: Equipment classification and requirements

INTERPRETATION SHEET 2

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

The text of this interpretation sheet is based on the following documents:

ISH	Report on voting
76/437/ISH	76/440/RVD

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

Subclause 8.3 f 3)

This subclause is clarified by the following:

Introduction

For pulse durations shorter than 1 ns, the application of the criterion given in 8.3 f 3) a) (the „$N^{-0,25}$ criterion“) produces overly-restrictive results when compared to the TOTP criterion 8.3 f 3) b).

NOTE This Interpretation Sheet also applies to MPE analyses (subclause A.3 c)).

Interpretation

In the wavelength range of 400 nm to 1 400 nm, the TOTP criterion (8.3 f 3) b)) can be applied for the case of pulse trains with pulses of the same energy and duration.

NOTE 1 If the “$N^{-0,25}$ criterion” is applied, it would have to be adopted as follows so that it results in equivalent evaluations as the TOTP criterion:

Pulses with durations less than T_i are assigned pulse durations of T_i. If two or more pulses occur within a duration of T_i, these pulse groups are assigned a pulse duration of T_i. The reduction factor C_5 is applied to the AEL that is applicable for T_i (i.e. $C_5 \cdot AEL(T_i)$). If one pulse occurs within T_i, the energy of that pulse is compared with the reduced AEL, i.e. with $C_5 \cdot AEL(T_i)$). If more than one pulse occurs within T_i, the sum of the energies of these pulses is compared with the reduced AEL.

NOTE 2 For the heading of 8.3 f 3) b)), instead of “for varying pulse widths or varying pulse durations” the intended wording was “for varying pulse widths or varying pulse intervals“ as corrected in Corrigendum 1”.

Rationale

For constant pulse durations and energies, the two criteria (the $N^{-0,25}$ and the TOTP criterion) should be, as a general principle, equivalent for all pulse durations, as both reflect the same

thermal additivity of multiple pulse exposures and constant pulse trains are a special case of non-constant pulse trains.

For pulse durations longer than T_i, the TOTP and the $N^{-0,25}$ criteria, as given in IEC 60825-1:2077, do produce mathematically identical evaluations. For pulse trains where individual pulse durations are shorter than 1 ns, because the $N^{-0,25}$ criterion is applied in IEC 60825-1 to the AEL for the single pulse (which for pulse durations less than 1 ns is smaller than the AEL for T_i of 18 μs or 50 μs), the $N^{-0,25}$ criterion and the TOTP criterion produce different results. Since both rules are intended to reflect thermal additivity of pulses, the TOTP is the more general criterion. Criteria that would make the current $N^{-0,25}$ criterion equivalent with the TOTP criterion are outlined in NOTE 1 above.

This instruction will remain valid until a new version of IEC 60825-1 is published.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF LASER PRODUCTS –

Part 1: Equipment classification and requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60825-1 has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

This second edition of IEC 60825-1 cancels and replaces the first edition published in 1993, its Amendment 1 (1997) and its Amendment 2 (2001). It constitutes a technical revision. The user's guide has been removed from this part of the IEC 60825 series and is now a separate document (Part 14). Light emitting diodes (LEDs) have been removed from the scope of this part of IEC 60825, but may still be included in other parts.

This part of IEC 60825 has the status of a Group Safety Publication, in accordance with IEC Guide 104[1)], for aspects of laser radiation pertaining to human safety.

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

CDV	Report on voting
76/338/CDV	76/357/RVC

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The list of all parts of the IEC 60825 series, published under the title *Safety of laser products*, can be found on the IEC website.

This part of IEC 60825 is also referred to as "Part 1" in this publication.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of August 2008 have been included in this copy.

1) IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*
It gives guidance to IEC technical committees and to writers of specifications concerning the manner in which safety publications should be drafted.
This guide does not constitute a normative reference and reference to it is given for information only.

SAFETY OF LASER PRODUCTS –

Part 1: Equipment classification and requirements

1 Scope and object

IEC 60825-1 is applicable to safety of laser products emitting laser radiation in the wavelength range 180 nm to 1 mm.

A laser product may consist of a single laser with or without a separate power supply or may incorporate one or more lasers in a complex optical, electrical, or mechanical system. Typically, laser products are used for demonstration of physical and optical phenomena, materials processing, data reading and storage, transmission and display of information, etc. Such systems have found use in industry, business, entertainment, research, education, medicine and consumer products.

Laser products that are sold to other manufacturers for use as components of any system for subsequent sale are not subject to IEC 60825-1, since the final product will itself be subject to this standard. However, if the laser system within the laser product is operable when removed from the equipment, the requirements of this Part 1 apply to the removable unit.

NOTE 1 Operable equipment does not require a tool to prepare for operation.

Any laser product is exempt from all further requirements of this Part 1 if classification by the manufacturer of that product according to Clauses 3, 8 and 9 shows that the emission level does not exceed the AEL (accessible emission limit) of Class 1 under all conditions of operation, maintenance, service and failure.

NOTE 2 The above exemption is to ensure that inherently safe laser products are not unnecessarily subject to the standard.

In addition to the hazards resulting from laser radiation, laser equipment may also give rise to other hazards such as fire and electric shock.

NOTE 3 However, the classification and other requirements of this standard are intended to address only the laser radiation hazards to the eyes and skin. Other hazards are not included within its scope.

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 must conform to the applicable performance and testing requirements of the applicable product safety standards.

NOTE 4 Other standards may contain additional requirements. Consideration should also be given to the intended application and user group. 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), audio and video equipment (IEC 60065), 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 applies.

In previous editions, LEDs were included in the scope of IEC 60825-1, and they may be still included in other parts of the IEC 60825 series. However, with the development of lamp safety standards, optical radiation safety of LEDs in general can be more appropriately addressed by lamp safety standards. The removal of LEDs from the scope of this Part 1 does not preclude other standards from including LEDs whenever they refer to lasers. CIE S009 may be applied to determine the risk group class of an LED or product incorporating one or more LEDs.

The MPE (maximum permissible exposure) values of this Part 1 were developed for laser radiation and do not apply to collateral radiation. However, if a concern exists that accessible collateral radiation might be hazardous, the laser MPE values may be applied to conservatively evaluate this potential hazard.

The MPE values are not applicable to intentional human exposure to laser radiation for the purpose of medical or cosmetic/aesthetic treatment.

NOTE 5 Annexes A to H have been included for purposes of general guidance and to illustrate many typical cases. However, the annexes are not regarded as definitive or exhaustive and reference should always be made to the appropriate clause(s) in the normative part of this document.

The objectives of this part of IEC 60825 are the following:

- to introduce a system of classification of lasers and laser products according to their degree of optical radiation hazard in order to aid hazard evaluation and to aid the determination of user control measures;
- to establish requirements for the manufacturer to supply information so that proper precautions can be adopted;
- to ensure, through labels and instructions, adequate warning to individuals of hazards associated with accessible radiation from laser products;
- to reduce the possibility of injury by minimizing unnecessary accessible radiation and to give improved control of the laser radiation hazards through protective features.

2) IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*