

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Safety of laser products –
Part 4: Laser guards**

**Sécurité des appareils à laser –
Partie 4: Protecteurs pour lasers**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
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 It also gives information on projects, withdrawn and replaced publications.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 60825-4

Edition 2.1 2009-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Safety of laser products –
Part 4: Laser guards**

**Sécurité des appareils à laser –
Partie 4: Protecteurs pour lasers**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.260

ISBN 978-2-88910-305-8

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Definitions	7
4 Laser processing machines	9
4.1 Design requirements	9
4.2 Performance requirements	10
4.3 Validation	10
4.4 User information.....	11
5 Proprietary laser guards.....	11
5.1 Design requirements	11
5.2 Performance requirements	11
5.3 Specification requirements	11
5.4 Test requirements	12
5.5 Labelling requirements	12
5.6 User information.....	13
Annex A (informative) General guidance on the design and selection of laser guards.....	14
Annex B (informative) Assessment of foreseeable exposure limit (FEL)	16
Annex C (informative) Elaboration of defined terms	23
Annex D (normative) Proprietary laser guard testing	25
Annex E (informative) Guidelines on the arrangement and installation of laser guards.....	27
Annex F (informative) Guideline for assessing the suitability of laser guards	37
Annex G (normative) Beam delivery systems.....	64
Bibliography.....	73
Figure B.1 – Calculation of diffuse reflections	17
Figure B.2 – Calculation of specular reflections	17
Figure B.3 – Some examples of a foreseeable fault condition	18
Figure B.4 – Four examples of errant laser beams that might have to be contained by a temporary guard under service conditions.....	19
Figure B.5 – Illustration of laser guard exposure during repetitive machine operation	20
Figure B.6 – Two examples of assessed duration of exposure	21
Figure B.7 – Assessed duration of exposure for a machine with no safety monitoring.....	22
Figure C.1 – Illustration of guarding around a laser processing machine	23
Figure C.2 – Illustration of active laser guard parameters	24
Figure D.1 – Simplified diagram of the test arrangement.....	26
Figure F.1 – Damage resistance of 1 mm thick zinc coated steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW CO ₂ laser	53
Figure F.2 – Damage resistance of 1 mm thick zinc coated steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW CO ₂ laser	53

Figure F.3 – Damage resistance of 2 mm thick zinc coated steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW CO ₂ laser	54
Figure F.4 – Damage resistance of 2 mm thick zinc coated steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW CO ₂ laser	54
Figure F.5 – Damage resistance of 3 mm thick zinc coated steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW CO ₂ laser	55
Figure F.6 – Damage resistance of 3 mm thick zinc coated steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW CO ₂ laser	55
Figure F.7 – Damage resistance of 2 mm thick aluminium sheet derived from 10 s exposure to a defocused beam during experiments using a CW CO ₂ laser.....	56
Figure F.8 – Damage resistance of 2 mm thick aluminium sheet derived from 100 s exposure to a defocused beam during experiments using a CW CO ₂ laser.....	56
Figure F.9 – Damage resistance of 1 mm thick stainless steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW CO ₂ laser.....	57
Figure F.10 – Damage resistance of 1 mm thick stainless steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW CO ₂ laser	57
Figure F.11 – Damage resistance of 6 mm thick polycarbonate sheet derived from 10 s exposure to a defocused beam during experiments using a CW CO ₂ laser.....	58
Figure F.12 – Damage resistance of 6 mm thick polycarbonate sheet derived from 100 s exposure to a defocused beam during experiments using a CW CO ₂ laser	58
Figure F.13 – Damage resistance of 1 mm thick zinc coated steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW Nd:YAG laser	59
Figure F.14 – Damage resistance of 1 mm thick zinc coated steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW Nd:YAG laser	59
Figure F.15 – Damage resistance of 2 mm thick zinc coated steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW Nd:YAG laser	60
Figure F.16 – Damage resistance of 2 mm thick zinc coated steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW Nd:YAG laser	60
Figure F.17 – Damage resistance of 3 mm thick zinc coated steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW Nd:YAG laser	61
Figure F.18 – Damage resistance of 3 mm thick zinc coated steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW Nd:YAG laser	61
Figure F.19 – Damage resistance of 2 mm thick aluminium sheet derived from 10 s exposure to a defocused beam during experiments using a CW Nd:YAG laser.....	62
Figure F.20 – Damage resistance of 2 mm thick aluminium sheet derived from 100 s exposure to a defocused beam during experiments using a CW Nd:YAG laser.....	62
Figure F.21 – Damage resistance of 1 mm thick stainless steel sheet derived from 10 s exposure to a defocused beam during experiments using a CW Nd:YAG laser.....	63
Figure F.22 – Damage resistance of 1 mm thick stainless steel sheet derived from 100 s exposure to a defocused beam during experiments using a CW Nd:YAG laser	63
Table D.1 – Laser guard classification	26
Table F.1 – Application of ALARP.....	40
Table G.1 – Beam delivery systems using free space beam delivery systems.....	69
Table G.2 – Beam delivery systems using fibre optic cables	71

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF LASER PRODUCTS –**Part 4: Laser guards**

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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 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 60825-4 has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

This consolidated version of IEC 60825-4 consists of the second edition (2006) [documents 76/342/FDIS and 76/351/RVD] and its amendment 1 (2008) [documents 76/383/FDIS and 76/385/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 2.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

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

The committee has decided that the contents of the base publication and its amendments 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.

This document is a preview generated by EVS

INTRODUCTION

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. 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.

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.

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.

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.

Where the term “irradiance” is used, the expression “irradiance or radiant exposure, as appropriate” is implied.

SAFETY OF LASER PRODUCTS –

Part 4: Laser guards

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.

2 Normative references

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.

IEC 60825-1:2007, *Safety of laser products – Part 1: Equipment classification and requirements*

ISO 11553-1:2005, *Safety of machinery – Laser processing machines – Safety requirements*

ISO 12100-1:2003, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology*

ISO 12100-2:2003, *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles and specifications*

ISO 13849-1:2006, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

ISO 14121-1:2007, *Safety of machinery – Risk assessment – Part 1: Principles*

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.