

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

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

Withdrawn



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2011 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 l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
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.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) 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 IEC

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

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

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 978-2-8891-2515-9

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

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.....	30
Annex F (informative) Guideline for assessing the suitability of laser guards	40
Annex G (normative) Beam delivery systems	67
Bibliography.....	76
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.....	27
Figure D.2 – Simplified diagram of the ventilation for the guard under test	27

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	56
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	56
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	57
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	57
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	58
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	58
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	59
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	59
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	60
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	60
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	61
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	61
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	62
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	62
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	63
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	63
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	64
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	64
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	65
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	65
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	66
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	66
Table D.1 – Laser guard test classification	28
Table F.1 – Application of ALARP	43
Table G.1 – Beam delivery systems using free space beam delivery systems	72
Table G.2 – Beam delivery systems using fibre optic cables	74

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.

This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 60825-4 edition 2.2 contains the second edition (2006) [documents 76/342/FDIS and 76/351/RVD], its amendment 1 (2008) [documents 76/383/FDIS and 76/385/RVD] and its amendment 2 (2011) [documents 76/428/CDV and 76/442/RVC].

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

International Standard IEC 60825-4 has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Withdrawn

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.

Withdrawn