

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



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

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

This is a preview. [Click here to purchase the full publication.](#)



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 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 Secretariat  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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 corrigendum or an amendment might have been published.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

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 It also gives information on projects, replaced and withdrawn publications.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](http://webstore.iec.ch/justpublished)

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

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://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: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

### 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.

#### Recherche de publications IEC -

[webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

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](http://webstore.iec.ch/justpublished)

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

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



---

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

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

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

---

ICS 31.260

ISBN 978-2-8322-3985-8

**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 .....	5
INTRODUCTION .....	7
1 Scope .....	8
2 Normative references .....	8
3 Terms and definitions .....	8
4 Requirements for laser guards .....	11
4.1 Requirement .....	11
4.2 Design requirements .....	12
4.3 Performance requirements .....	12
4.4 Validation .....	12
4.5 User information .....	13
5 Proprietary laser guards .....	13
5.1 General .....	13
5.2 Design requirements .....	13
5.3 Performance requirements .....	13
5.4 Specification requirements .....	14
5.5 Test requirements .....	14
5.6 Labelling requirements .....	14
5.7 User information .....	15
Annex A (informative) General guidance on the design and selection of laser guards .....	16
A.1 Design of laser guards .....	16
A.2 Selection of laser guards .....	16
Annex B (informative) Assessment of foreseeable exposure limit (FEL) .....	18
B.1 General .....	18
B.2 Reflection of laser radiation .....	19
B.3 Examples of assessment conditions .....	19
B.4 Exposure duration .....	22
Annex C (informative) Elaboration of defined terms .....	25
C.1 Distinction between FEL and PEL .....	25
C.2 Active guard parameters .....	25
Annex D (normative) Proprietary laser guard testing .....	27
D.1 General .....	27
D.2 Test conditions .....	27
D.3 Protection time corresponding to the specified protective exposure limit (PEL) .....	31
D.4 Information supplied by the manufacturer .....	31
Annex E (informative) Guidelines on the arrangement and installation of laser guards .....	33
E.1 Overview .....	33
E.2 General .....	33
E.3 Risk assessment .....	34
E.4 Examples of risk assessment .....	36
E.5 Aids to risk assessment .....	39
Annex F (informative) Guideline for assessing the suitability of laser guards .....	42
F.1 Identification of hazards .....	42
F.2 Risk assessment and integrity .....	42

F.3	General design .....	45
F.4	Selection of safeguards .....	46
F.5	Guard design and construction.....	46
F.6	Guard construction and materials.....	48
F.7	Other safety devices .....	50
F.8	Interlocking considerations .....	51
F.9	Environmental considerations .....	55
F.10	Installation consideration – Environmental factors – Services .....	56
F.11	Maintenance and service considerations.....	56
Annex G	(normative) Guided beam delivery systems .....	67
G.1	General.....	67
G.2	General requirements .....	67
G.3	Verification of safety requirements or protective measures .....	69
G.4	Information for users.....	69
G.5	Examples of risk assessments .....	70
Bibliography	.....	75
Figure B.1	– Calculation of diffuse reflections .....	19
Figure B.2	– Calculation of specular reflections .....	19
Figure B.3	– Some examples of a foreseeable fault condition .....	20
Figure B.4	– Four examples of errant laser beams that might have to be contained by a temporary guard under service conditions.....	21
Figure B.5	– Illustration of laser guard exposure during repetitive machine operation .....	22
Figure B.6	– Two examples of assessed duration of exposure .....	23
Figure B.7	– Assessed duration of exposure for a machine with no safety monitoring .....	24
Figure C.1	– Illustration of guarding around a laser processing machine.....	25
Figure C.2	– Illustration of active laser guard parameters .....	26
Figure D.1	– Simplified diagram of the test arrangement.....	29
Figure D.2	– Simplified diagram of the ventilation for the guard under test.....	29
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 <sub>2</sub> laser.....	57
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 <sub>2</sub> laser.....	58
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 <sub>2</sub> laser .....	58
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 <sub>2</sub> laser.....	58
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 <sub>2</sub> laser .....	59
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 <sub>2</sub> laser.....	59
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 <sub>2</sub> 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 <sub>2</sub> laser .....	60

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 <sub>2</sub> 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 <sub>2</sub> 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 <sub>2</sub> 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 <sub>2</sub> 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.....	30
Table F.1 – Application of ALARP .....	45
Table G.1 – Beam delivery systems using free space beam delivery systems .....	70
Table G.2 – Beam delivery systems using fibre optic cables .....	72

## 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.

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

This third edition cancels and replaces the second edition published in 2006, Amendment 1:2008 and Amendment 2:2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Significant amendments have been included and this edition has been prepared for user convenience.

The text of this International Standard is based on the following documents:

Draft	Report on voting
76/704/FDIS	76/711/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

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

**IMPORTANT – The "colour inside" logo on the cover page of this document 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.**



## 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.

Laser guards may also comply with standards for laser protective eyewear, but such compliance is not necessarily sufficient to satisfy the requirements of this document.

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 document applies to all component parts of a guard including clear (visibly transmitting) screens and viewing windows, panels, laser curtains and walls.

In addition, this document indicates

- a) how to assess and specify the protective properties of a laser guard, and
- b) how to select a laser guard.

NOTE 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.

This document deals with protection against laser radiation only. Hazards from secondary radiation that may arise during material processing are not addressed.

#### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60825-1:2014, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

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

ISO 12100, *Safety of machinery – General principles for design – Risk assessment and risk reduction*

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

#### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60825-1 and the following apply.