

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

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

STANDARD PREVIEW
(standards.iteh.ai)
IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV
<https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv>



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 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 It also gives information on projects, withdrawn and replaced publications.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

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

STANDARD PREVIEW
(standards.iteh.ai)

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

[IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv)
<https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

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.

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], 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].

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

It bears the edition number 2.2.

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

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.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV
https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv)

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.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv)
<https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv>

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.

3.1
active guard protection time

for a given laser exposure of the front surface of an active laser guard, the minimum time, measured from the issue of an active guard termination signal, for which the active laser guard can safely prevent laser radiation accessible at its rear surface from exceeding the class 1 AEL

3.2
active guard termination signal

the signal issued by an active guard in response to an excess exposure of its front surface to laser radiation and which is intended to lead to automatic termination of the laser radiation

NOTE The action of a safety interlock becoming open circuit is considered a "signal" in this context.

3.3
active laser guard

a laser guard which is part of a safety-related control system. The control system generates an active guard termination signal in response to the effect of laser radiation on the front surface of the laser guard

3.4
foreseeable exposure limit

FEL

the maximum laser exposure on the front surface of the laser guard, within the maintenance inspection interval, assessed under normal and reasonably foreseeable fault conditions

3.5
front surface

the face of the laser guard intended for exposure to laser radiation

3.6
laser guard

a physical barrier which limits the extent of a danger zone by preventing laser radiation accessible at its rear surface from exceeding the class 1 AEL

3.7
laser processing machine

a machine which uses a laser to process materials and is within the scope of ISO 11553-1

3.8
laser termination time

the maximum time taken, from generation of an active guard termination signal, for the laser radiation to be terminated

NOTE Laser termination time does not refer to the response of an active laser guard but to the response of the laser processing machine, in particular the laser safety shutter.

3.9
maintenance inspection interval

the time between successive safety maintenance inspections of a laser guard

3.10
passive laser guard

a laser guard which relies for its operation on its physical properties only

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481cc06bf1/iec-60825-4-2006amd1-2008amd2-2011-csv)

[https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481cc06bf1/iec-60825-4-2006amd1-2008amd2-2011-csv)

[7f481cc06bf1/iec-60825-4-2006amd1-2008amd2-2011-csv](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481cc06bf1/iec-60825-4-2006amd1-2008amd2-2011-csv)

3.11

process zone

the zone where the laser beam interacts with the material to be processed

3.12

proprietary laser guard

a passive or active laser guard, offered by its manufacturer as a guard with a specified protective exposure limit

3.13

protective exposure limit

PEL

the maximum laser exposure of the front surface of a laser guard which is specified to prevent laser radiation accessible at its rear surface from exceeding the class 1 AEL

NOTE 1 In practice, there may be more than one maximum exposure.

NOTE 2 Different PELs may be assigned to different regions of a laser guard if these regions are clearly identifiable (for example a viewing window forming an integral part of a laser guard).

3.14

rear surface

any surface of a laser guard that is remote from the associated laser radiation and usually accessible to the user

iTeh STANDARD PREVIEW

3.15

reasonably foreseeable

(standards.iteh.ai)

an event (or condition) when it is credible and its likelihood of occurrence (or existence) cannot be disregarded

[IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv)

[https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv)

[7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv)

3.16

safety maintenance inspection

documented inspection performed in accordance with manufacturer's instructions

3.17

temporary laser guard

a substitute or supplementary active or passive laser guard intended to limit the extent of the danger zone during some service operations of the laser processing machine

4 Laser processing machines

This clause specifies the requirements for laser guards that enclose the process zone and are supplied by the laser processing machine manufacturer.

4.1 Design requirements

A laser guard shall satisfy ISO 12100-2 with respect to the general requirements for guards and also the more specific requirements with regard to its location and method of fixture. In addition, the following specific laser requirements shall be met.

4.1.1 General requirements

A laser guard, in its intended location, shall not give rise to any associated hazard at or beyond its rear surface when exposed to laser radiation up to the foreseeable exposure limit.

NOTE 1 Examples of associated hazards include: high temperature, the release of toxic materials, fire, explosion, electricity.

NOTE 2 See Annex B for assessment of foreseeable exposure limit.

4.1.2 Consumable parts of laser guards

Provision shall be made for the replacement of parts of a laser guard prone to damage by laser radiation.

NOTE An example of such a part would be a sacrificial or interchangeable screen.

4.2 Performance requirements

4.2.1 General

When the front surface of a laser guard is subjected to exposure to laser radiation at the foreseeable exposure limit, the laser guard shall prevent laser radiation accessible at its rear surface from exceeding the class 1 AEL at any time over the period of the maintenance inspection interval. For automated laser processing machines, the minimum value of the maintenance inspection interval shall be 8 h.

This requirement shall be satisfied over the intended lifetime of the laser guard under expected conditions of operation.

NOTE 1 This requirement implies both low transmission of laser radiation and resistance to laser-induced damage.

NOTE 2 Some materials may lose their protective properties due to ageing, exposure to ultraviolet radiation, certain gases, temperature, humidity and other environmental conditions. Additionally, some materials will transmit laser radiation under high-intensity laser exposure, even though there may be no visible damage (i.e. reversible bleaching).

4.2.2 Active laser guards

- a) The active guard protection time shall exceed the laser termination time up to the foreseeable exposure limits.
- b) The generation of an active guard termination signal shall give rise to a visible or audible warning. A manual reset is required before laser emission can recommence.

NOTE See Annex C.2 for an elaboration of terms.

4.3 Validation

If the laser processing machine manufacturer chooses to make a laser guard, the manufacturer shall confirm that the guard complies with the design requirements of 4.1 and can satisfy the performance requirements set out in 4.2.

NOTE See Annex A for guidance on the design and selection of laser guards.

4.3.1 Validation of performance

4.3.1.1 The complete laser guard, or an appropriate sample of the material of construction of the laser guard, shall be tested at each FEL identified.

NOTE 1 A table of predetermined PELs for common combinations of lasers and guarding materials, together with suitable testing procedures shall be issued as an informative annex in a future amendment to this standard. This could provide a simple alternative to direct testing for the majority of cases.

NOTE 2 See Annex B for the assessment of FEL.

4.3.1.2 For testing purposes, the FEL exposure shall be achieved either:

- a) by calculating or measuring the exposure and reproducing the conditions; or
- b) without quantifying the FEL, by creating the machine conditions under which the FEL is produced.

The condition of the laser guard or sample shall be such as to replicate those physical conditions of the front surface permitted within the scope of the routine inspection instructions and within the service life of the guard, which minimize the laser radiation protective properties of the laser guard (for example wear and tear and surface contamination) (see 4.4.2).

4.4 User information

4.4.1 The manufacturer shall document and provide to the user the maintenance inspection interval for the laser guard, and details of inspection and test procedures, cleaning, replacement or repair of damaged parts, together with any restrictions of use.

4.4.2 The manufacturer shall document and provide to the user instructions that after any actuation of the safety control system of an active guard, the cause shall be investigated, checks shall be made for damage, and the necessary remedial action to be taken before resetting the control system.

5 Proprietary laser guards

iTeh STANDARD PREVIEW
(standards.iteh.ai)

This clause specifies the requirements to be satisfied by suppliers of proprietary laser guards.

5.1 Design requirements

A proprietary laser guard shall not create any associated hazard at or beyond its rear surface when exposed to laser radiation up to the specified PEL when used as specified in the user information (see 5.6).

5.2 Performance requirements

The accessible laser radiation at the rear surface of the laser guard shall not exceed the class 1 AEL when its front surface is subjected to laser radiation at the specified PEL. For an active laser guard, this requirement shall apply to laser radiation accessible over the period of the active guard protection time, measured from the moment an active guard termination signal is issued.

This requirement shall be satisfied over the intended lifetime of the guard under expected service conditions.

5.3 Specification requirements

The full specification of a PEL shall include the following information:

- a) the magnitude and variation with time of irradiance or radiant exposure at the front surface of the laser guard (in units of Wm^{-2} or Jm^{-2} respectively), specifying any upper limit to the area of exposure;
- b) the overall duration of exposure under these conditions;
- c) the wavelength for which this PEL applies;
- d) the angle of incidence and (if relevant) the polarization of the incident laser radiation;

- e) any minimum dimensions to the irradiated area (for example as might apply to an active laser guard with discrete sensor elements so that a small diameter laser beam could pass through the guard undetected);
- f) for an active laser guard, the active guard protection time.

NOTE 1 See Clause B.1 for an elaboration of terms.

NOTE 2 In all cases, a range or set of values can be stated rather than a single value.

NOTE 3 A graphical form of presentation is acceptable (for example irradiance vs. duration with all other parameters constant).

5.4 Test requirements

5.4.1 General

Testing shall be performed using the complete laser guard or an appropriate sample of the material used to construct the guard. In either case, the condition of the guard or sample shall be such as to replicate or exceed the worst permissible physical condition of the front surface, including reduced surface reflection and damage permitted within the scope of the routine maintenance instructions (see 5.6).

The front surface irradiation shall be either as specified by the PEL or, in the case of sample testing, as specified in 5.4.2 below.

When the front surface is subjected to the PEL exposure conditions, the accessible laser radiation measured at the rear surface of the laser guard shall not exceed the class 1 AEL (tests as prescribed in Clause 8 of 60825-1). This requirement applies over the exposure duration specified in the PEL or, in the case of an active guard, over the specified active guard protection time measured from the moment an active guard termination signal is issued.

[IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV](#)

NOTE In cases where materials opaque at the laser wavelength(s) are used (for example metals), the transmitted radiation will only rise to the class 1 AEL when complete (or almost complete) physical removal of material along a path through to the rear surface has been achieved. In such cases, the rise from zero transmission to a value greatly in excess of the class 1 AEL will therefore be rapid, and sensitive radiation detectors will not be required.

5.4.2 Sample testing

Sample guard testing shall be performed by irradiating the front surface of the guard material using the procedure and methodology as specified in Annex D.

5.5 Labelling requirements

5.5.1 All labelling shall be placed on the rear surface of the guard.

5.5.2 The rear surface of the guard shall be clearly identified if the orientation of the guard is important.

5.5.3 If only part of the front surface of the guard is a laser guard, this area shall be clearly identified by a bold coloured outline and words to indicate the outer boundary of the laser guard.

5.5.4 The labelling shall state the full PEL specification.

5.5.5 The manufacturer's name, the date and place of manufacture according to ISO 11553-1, and a statement of compliance with this standard shall be provided.

5.6 User information

In addition to the specifications listed in 5.3, the following information shall be supplied to the user by the manufacturer of a proprietary laser guard:

- a) a description of the permitted uses of the laser guard;
- b) a description of the form of mounting and connection of the laser guard;
- c) information on the installation of the laser guard – for active laser guards this shall include interface and supply requirements for the guard;
- d) maintenance requirements, including for example details of inspection and test procedures, cleaning, replacement or repair of damaged parts;
- e) instructions, that after any actuation of the safety control system of an active guard, the cause shall be investigated, checks shall be made for damage, and the necessary remedial action to be taken before resetting the control system;
- f) the labels in 5.5 and their locations. If only part of the front surface of the guard is a laser guard, this area shall be identified;
- g) a statement of compliance with this standard.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[IEC 60825-4:2006+AMD1:2008+AMD2:2011 CSV](https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv)
<https://standards.iteh.ai/catalog/standards/sist/d52a88b9-f600-413d-9a25-7f481ce06bfd/iec-60825-4-2006amd1-2008amd2-2011-csv>