

Safety of laser products —

Part 2: Safety of optical fibre communication systems (OFCS)

ICS 31.260; 33.180.01

National foreword

This British Standard is the UK implementation of EN 60825-2:2004+A2:2010. It is identical to IEC 60825-2:2004, incorporating amendments 1:2006 and 2:2010. It supersedes BS EN 60825-2:2004+A1:2007 which will be withdrawn on 1 October 2013.

National Annex NA added with IEC Interpretation Sheet 1 (January 2007).

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted to Technical Committee EPL/76, Optical radiation safety and laser equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Safety of laser products
Part 2: Safety of optical fibre communication systems (OFCS)
(IEC 60825-2:2004)

Sécurité des appareils à laser
Partie 2: Sécurité des systèmes
de télécommunication par fibres optiques
(STFO)
(CEI 60825-2:2004)

Sicherheit von Lasereinrichtungen
Teil 2: Sicherheit von Lichtwellenleiter-
Kommunikationssystemen (LWLKS)
(IEC 60825-2:2004)

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CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 76/288/FDIS, future edition 3 of IEC 60825-2, prepared by IEC TC 76, Optical radiation safety and laser equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60825-2 on 2004-09-01.

This European Standard supersedes EN 60825-2:2000. It constitutes a technical revision to bring the hazard level nomenclature used in this document into correspondence with the revised classification system introduced in amendment A2:2001 to EN 60825-1:1994. Additionally, the standard has been thoroughly revised throughout.

The following dates were fixed:

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Endorsement notice

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Foreword to amendment A1

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Foreword to amendment A2

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

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|---|-------|------------|
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Endorsement notice

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SAFETY OF LASER PRODUCTS –

Part 2: Safety of optical fibre communication systems (OFCS)

1 Scope and object

This Part 2 of IEC 60825 provides requirements and specific guidance for the safe operation and maintenance of optical fibre communication systems (OFCS). In these systems optical power may be accessible outside the confinements of transmitting equipment or at great distance from the optical source.

This Part 2 requires the assessment of hazard levels at accessible locations as a replacement for classification according to IEC 60825-1. It applies to the complete installed end-to-end OFCS, including its components and subassemblies that generate or amplify optical radiation. Individual components and subassemblies that are sold only to OEM vendors for incorporation into a complete installed end-to-end OFCS need not be assessed to this standard, since the final OFCS should itself be assessed according to this standard.

A2 NOTE 1 The above statement is not intended to prevent manufacturers of such components and subassemblies from using this standard if they wish to do so, or are required to do so by contract. 

This standard does not apply to optical fibre systems primarily designed to transmit optical power for applications such as material processing or medical treatment.

In addition to the hazards resulting from laser radiation, OFCS may also give rise to other hazards, such as fire.

This standard does not address safety issues associated with explosion or fire with respect to OFCS deployed in explosive atmospheres.

Throughout this part of IEC 60825, a reference to 'laser' is taken to include light-emitting diodes (LEDs) and optical amplifiers.

A2 NOTE 2 The optical hazard of light emerging from a fibre is determined by the wavelength and power emerging from the fibre and the optical characteristics of the fibre. (See Annex A.). 

The objective of this Part 2 of IEC 60825 is to:

- protect people from optical radiation resulting from OFCS;
- provide requirements for manufacturers, installation organizations, service organizations and operating organizations in order to establish procedures and supply information so that proper precautions can be adopted;
- ensure adequate warnings are provided to individuals regarding the potential hazards associated with OFCS through the use of signs, labels and instructions.

Annex A gives a more detailed rationale for this part of IEC 60825.

The safety of an OFCS depends to a significant degree on the characteristics of the equipment forming that system. Depending on the characteristics of the equipment, it may be necessary to mark safety relevant information on the product or include it within the instructions for use.

Where required by the level of potential hazard, it places the responsibility for the safe deployment and use of these systems on the installer or end-user / operating organization or both. This standard places the responsibility for adherence to safety instructions during installation and service operations on the installation organization and service organizations as appropriate, and operation and maintenance functions on the end-user or operating organization. It is recognised that the user of this standard may fall into one or more of the aforementioned categories of manufacturer, installation organization, end-user or operating organization.

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* 

3 Terms and definitions

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

3.1

accessible location

any part or location within an OFCS at which, under reasonably foreseeable events, human access to laser radiation is possible without the use of a tool

3.2

automatic power reduction (APR)

a feature of an OFCS by which the accessible power is reduced to a specified level within a specified time, whenever there is an event which could result in human exposure to radiation, e.g. a fibre cable break

NOTE The term “automatic power reduction” (APR) used in this standard encompasses the following terms used in recommendations of the International Telecommunication Union ITU:

- automatic laser shutdown (ALS);
- automatic power reduction (APR);
- automatic power shutdown (APSD).

3.3

end-user

person or organization using the OFCS in the manner the system was designed to be used

NOTE 1 The end-user cannot necessarily control the power generated and transmitted within the system.

NOTE 2 If the person or organization is using the OFCS for a communications application in a manner other than as designed by the manufacturer, then that person/organization assumes the responsibilities of a manufacturer or installation organization.

3.4

hazard level

the potential hazard at any accessible location within an OFCS. It is based on the level of optical radiation which could become accessible in a reasonably foreseeable event, e.g. a fibre cable break. It is closely related to the laser classification procedure in IEC 60825-1

3.5

hazard level 1

hazard level 1 is assigned to any accessible location within an OFCS at which, under reasonably foreseeable events, human access to laser radiation in excess of the accessible emission limits of Class 1 for the applicable wavelengths and emission duration will not occur.

-  The level of radiation is measured with the conditions for Class 1 laser products (see IEC 60825-1), but with condition 2 being as defined in clause 4.8.1 of this standard (IEC 60825-2) 

3.6

hazard level 1M

hazard level 1M is assigned to any accessible location within an OFCS at which, under a reasonably foreseeable event, human access to laser radiation in excess of the accessible emission limits of Class 1 for the applicable wavelengths and emission duration will not occur.

- A₂** The level of radiation is measured with the conditions for Class 1M laser products (see IEC 60825-1), but with condition 2 being as defined in clause 4.8.1 of this standard (IEC 60825-2) **A₂**

NOTE If the applicable limit of hazard level 1M is larger than the limit of 2 or 3R and less than the limit of 3B, hazard level 1M is allocated.

3.7

hazard level 2

hazard level 2 is assigned to any accessible location within an OFCS at which, under a reasonably foreseeable event, human access to laser radiation in excess of the accessible emission limits of Class 2 for the applicable wavelengths and emission duration will not occur.

- A₂** The level of radiation is measured with the conditions for Class 2 laser products (see IEC 60825-1), but with condition 2 being as defined in clause 4.8.1 of this standard (IEC 60825-2) **A₂**

NOTE If the applicable limit of hazard level 1M is larger than the limit of 2 and less than the limit of 3B, hazard level 1M is allocated.

3.8

hazard level 2M

hazard level 2M is assigned to any accessible location within an OFCS at which, under a reasonably foreseeable event, human access to laser radiation in excess of the accessible emission limits of Class 2 for the applicable wavelengths and emission duration will not occur.

- A₂** The level of radiation is measured with the conditions for Class 2M laser products (see IEC 60825-1), but with condition 2 being as defined in clause 4.8.1 of this standard (IEC 60825-2) **A₂**

NOTE If the applicable limit of hazard level 2M is larger than the limit of 3R and less than the limit of 3B, hazard level 2M is allocated.

3.9

hazard level 3R

hazard level 3R is assigned to any accessible location within an OFCS at which, under a reasonably foreseeable event, human access to laser radiation in excess of the accessible emission limits of Class 3R for the applicable wavelengths and emission duration will not

- A₂** occur. The level of radiation is measured with the conditions for Class 3R laser products (see IEC 60825-1), but with condition 2 being as defined in clause 4.8.1 of this standard (IEC 60825-2) **A₂**

NOTE If the applicable limit of hazard level 1M or 2M is larger than the limit of 3R and less than the limit of 3B, hazard level 1M or 2M is allocated.

3.10

hazard level 3B

hazard level 3B is assigned to any accessible location within an OFCS at which, under a reasonably foreseeable event, human access to laser radiation in excess of the accessible emission limits of Class 3B for the applicable wavelengths and emission duration will not

- A₂** occur. The level of radiation is measured with the conditions for Class 3B laser products (see IEC 60825-1), but with condition 2 being as defined in clause 4.8.1 of this standard (IEC 60825-2) **A₂**

3.11

hazard level 4

hazard level 4 is assigned to any accessible location within an OFCS at which, under a reasonably foreseeable event, human access to laser radiation in excess of the accessible emission limits of Class 3B for the applicable wavelengths and emission duration may occur.

A2 The level of radiation is measured with the conditions for Class 3B laser products (see IEC 60825-1), but with condition 2 being as defined in clause 4.8.1 of this standard (IEC 60825-2) **A2**

NOTE This standard is applicable for the operation and maintenance of OFCS. In order to achieve an adequate level of safety for persons who may come into contact with the optical transmission path, hazard level 4 is not permitted within this standard. It is permitted to use protection systems, such as automatic power reduction, to achieve the required hazard level where the transmitted power under normal operating conditions (e.g. no fault exists in the fibre path) exceeds that permitted for a particular location type. For instance, it is possible for accessible parts of an OFCS to be hazard level 1 even though the power transmitted down the fibre under normal operating conditions is Class 4.

3.12

installation organization

an organization or individual that is responsible for the installation of an OFCS

3.13

location with controlled access; controlled location

an accessible location where an engineering or administrative control is present to make it inaccessible, except to authorized personnel with appropriate laser safety training

NOTE For examples see D.2.1 a).

3.14

location with restricted access; restricted location

an accessible location that is normally inaccessible by the general public by means of any administrative or engineering control measure but that is accessible to authorized personnel who may not have laser safety training

NOTE For examples see D.2.1 b).

3.15

location with unrestricted access; unrestricted location

an accessible location where there are no measures restricting access to members of the general public

NOTE For examples see D.2.1 c).

3.16

manufacturer

organization or individual that assembles optical devices and other components in order to construct or modify an OFCS

3.17

operating organization

organization or individual that is responsible for the operation of an OFCS

3.18

optical fibre communication system (OFCS)

an engineered, end-to-end assembly for the generation, transfer and reception of optical radiation arising from lasers, LEDs or optical amplifiers, in which the transference is by means of optical fibre for communication and/or control purposes

3.19**reasonably foreseeable event**

an event the occurrence of which under given circumstances can be predicted fairly accurately, and the occurrence probability or frequency of which is not low or very low

NOTE Examples of reasonably foreseeable events might include the following: fibre cable break, optical connector disconnection, operator error or inattention to safe working practices.

Reckless use or use for completely inappropriate purposes is not considered as a reasonably foreseeable event.

3.20**service organization**

an organization or individual that is responsible for the servicing of an OFCS

3.21**subassembly**

any discrete unit, subsystem, network element, or module of an OFCS which contains an optical emitter or optical amplifier

4 Requirements**4.1 General**

This section defines the restrictions that are to be placed on an OFCS and on the location types in which an OFCS can operate, in accordance with the hazard that arises from optical radiation becoming accessible as a result of a reasonably foreseeable event. Whenever one or more alterations are made to an OFCS, the organization responsible for that alteration shall make a determination of whether each alteration could affect the hazard level. If the hazard level has changed, the organization responsible for the alteration(s) shall re-label those locations in the system that are accessible so as to ensure continued compliance with this standard.

Each accessible location within an OFCS shall be separately assessed to determine the hazard level at that location. Where multiple communications systems are present at a location, the hazard level for the location shall be the highest of the levels arising from each of those systems. Based on the hazard level determined, appropriate actions shall be taken to ensure compliance with this standard. These actions could for example involve restriction of access to the location, or the implementation of safety features or redesign of the optical communications system to reduce the hazard level.

Suppliers of active components and subassemblies in conformance with this standard that do not comprise an OFCS need to comply only with the applicable portions of Clause 4.

OFCS that also transmit electrical power shall meet the requirements of this standard in addition to any applicable electrical standard.

NOTE When determining the hazard level, two characteristics have to be taken into account.

1) What is the maximum permissible exposure (MPE)? The level of exposure must be determined at a location where it is reasonably foreseeable that a person could be exposed to radiation coming from the OFCS. The time taken for the APR system (if present) to operate must be included when determining the MPE. If the OFCS does not incorporate APR, then meeting the requirements referred to in Note 2 below will be taken as automatically meeting the requirements of this Note 1 without further investigation or tests. Requirements are described in 4.8.2.

2) What is the maximum permitted power at which the OFCS can operate after a reasonable foreseeable event (such as a fibre-break) has caused the radiation to become accessible? This maximum power value could be lower than the normal operating power in the fibre as a result of activation of the APR system. Requirements are described in 4.8.1.

4.2 Protective housing of OFCS

Each OFCS shall have a protective housing which, when in place, prevents human access to laser radiation in excess of hazard level 1 limits under normal operating conditions.

4.3 Fibre cables

If the potential hazard at any accessible location within an OFCS is hazard level 1M, 2M, 3R or 3B, then the fibre optic cable shall have mechanical properties appropriate to its physical location. Cables for various physical locations are described in the IEC 60794 series. Where necessary, additional protection, for example ducting, conduit or raceway, may be required for locations where the fibre would otherwise be susceptible to damage.

4.4 Cable connectors

The following requirements for cable connectors may be achieved by the mechanical design of the connectors, or by the positioning of the connector, or by any other suitable means. Whichever means is chosen, human access to radiation above that permitted for connectors in a particular location type shall be prevented.

NOTE The use of a tool for disconnection is one example of a mechanical solution.

4.4.1 Unrestricted locations

In unrestricted locations, if the accessible radiation level exceeds:

- hazard level 2 within the wavelength range 400 nm to 700 nm, or
- hazard level 1 in all other cases,

then suitable means shall limit access to the radiation from the connector.

NOTE In an unrestricted location the highest hazard levels permitted are hazard level 2M for the wavelength range 400 nm to 700 nm and hazard level 1M in all other cases (see 4.9.1)

4.4.2 Restricted locations

In restricted locations, if the accessible radiation level exceeds:

- hazard level 2M within the wavelength range 400 nm to 700 nm, or
- hazard level 1M in all other cases,

then suitable means shall limit access to the radiation from the connector.

NOTE In a restricted location the highest hazard level permitted is hazard level 1M, 2M or 3R, whichever is the higher (see 4.9.2).

4.4.3 Controlled locations

In controlled locations, if the accessible radiation level exceeds:

- hazard level 2M within the wavelength range 400 nm to 700 nm, or
- hazard level 1M in all other cases,

then suitable means shall limit access to the radiation from the connector.

NOTE In a controlled location the highest hazard level permitted is hazard level 3B (see 4.9.3). 

4.5 Automatic power reduction (APR) and restart pulses

If equipment makes use of an automatic power reduction (APR) system in order to reduce its assigned hazard level, then it shall be restarted with restrictions which are described in the following three scenarios. In addition, the APR shall be designed to have an adequate level of reliability (see Note 1).

NOTE 1 Examples of calculating the reliability of APR systems are given in Clause D.5.

NOTE 2 The restart interval described in the following scenarios is wavelength-dependent as described in IEC 60825-1.

4.5.1 Automatic restart

In the case where the restart is initiated automatically, the timing and power of the restart process shall be restricted such that the hazard level assigned to each accessible location of the system shall not be exceeded.

4.5.2 Manual restart with assured continuity

In the case where the restart is initiated manually and the continuity of the communications path is assured by the use of administrative controls or other means, the timing and power of the restart process is not restricted (see Note 3). The manufacturer's instructions shall specify that administrative controls (or other means) must take account of the fact that the assigned hazard level at any accessible location may be exceeded during this restart procedure.

NOTE 3 Since in this case the timing and power of the restart process is not restricted, the administrative or other controls will need to take into consideration any increased risk of new hazards (such as fire). It is important that these additional controls be documented in the appropriate service instructions.

4.5.3 Manual restart without assured continuity

In the case where the restart is initiated manually and the continuity of the communications path is not assured, the timing and power of the restart process shall be restricted such that the hazard level assigned to each accessible location of the system shall not be exceeded.

4.5.4 Disabling of the APR

If a manual initiated restart of the system temporarily inactivates the APR, the system must indicate that the APR is not operable for the duration of the reboot so that the operating organization can take the appropriate precautions. Unless these conditions are met, the hazard level must be assigned using the transmitting power level before APR.

Disabling of the APR mechanism shall not be permitted for Class 3B and 4 transmitting powers, unless all of the following conditions are met:

- 1) that such disabling is necessary only for the infrequent incidences of system installation and service;
 - 2) that such disabling can only be done via software commands or a manual lockout key system;
 - 3) if disabling is done via software commands, incorporated in such software shall be a security system that prevents inadvertent disabling of the APR mechanism;
 - 4) that such software incorporate a warning indicator that the APR will be disabled if the procedure is continued;
 - 5) continuous operation of the traffic-carrying OFCS with APR disabled shall be prevented by suitable engineering means;
 - 6) proper instructions on the safe use of the equipment with the disabled APR are included in the documentation.
 -  7) it shall not be possible to disable the APR permanently – the APR must automatically re-enable (see also note 3);
 - 8) it shall only be possible to disable APR at the transmitting equipment (i.e. remote disabling of the APR is not normally permitted), except when in direct communication with persons (possibly at remote locations) likely to be exposed to higher levels of radiation than before the APR is disabled.
- NOTE 1 Consideration should be given to the fact that Raman systems may also emit high power from the receive termination.
- 9) a clear and unambiguous warning shall be displayed continuously while the APR remains disabled;
 - 10) manual start-up or re-start of high power systems with APR disabled 

- A2** It is recognised that systems utilising high optical powers (by their very nature) must use high powers to ensure continuity - otherwise no signal will be received at the far end. Therefore it is permitted to use high powers (class 4) at initial system start-up, provided this is done by trained personnel under defined conditions.

Every effort must be made to ensure system continuity (i.e. OTDR continuity testing from both ends of the system) and to ensure personnel are not exposed to class 3B or class 4 radiation. This can also be done by rigorous administrative controls.

NOTE 2 Except where otherwise explicitly stated, this standard does not permit end-to-end OFCS to operate if accessible locations within that system are hazard level 4. If the transmitting power of a transmitter, amplifier, etc. is Class 4 and the APR has been disabled, then the result would be accessible locations operating at hazard level 4. Nevertheless, it is recognised that it may be necessary to disable the APR in certain conditions, but these conditions need to be well controlled and time-limited so that the probability of exposure to a Class 4 radiation is very low.

NOTE 3 Regarding condition 5), an example of a 'suitable engineering means' is a control system that automatically re-enables the APR as soon as practicable after a time interval that is long enough to complete whatever task that caused the APR to be initially deactivated.

NOTE 4 One hour is suggested as a suitable time after which the APR should re-enable. **A2**

4.6 Labelling or marking

A1 4.6.1 General requirements

Where required by this subclause, each optical connector, splice box or other part emitting radiation when opened shall be marked (e.g. with a label, sleeve, tag, tape etc.), if the hazard level at the location is in excess of hazard level 1. The information shall consist of the information identified in Tables 1, 2 or 3 as applicable.

Where the accessible radiation at points of disconnection is hazard level 1 or hazard level 1M it is permitted for the above information to be provided in information for the user instead of as a marking on the product.

Markings shall be coloured black on a yellow background. Labels reproduced in the documentation provided by the manufacturer or by the operating organisation are permitted to use black on a white background.

It is acceptable to reduce the marking in size, providing that the result is legible. For subassemblies containing lasers or optical amplifiers, it is the responsibility of the manufacturer of the subassembly to provide such labelling; all other labelling is the responsibility of the operating organization. **A1**

A1 Except as permitted below, each optical connector, splice box or other part that is intended to permit access to optical radiation when opened shall be marked (e.g. with a label, sleeve, tag, tape etc.) in accordance with Tables 1, 2 or 3, as applicable.

In addition to the marking required in this Part 2, certain subassemblies may also need to be marked because of their stand-alone application under Part 1, and in such situations it is left to the manufacturer of the OFCS whether they supplement the marking required by Part 1 or replace it with the marking as required by Part 2.

Table 1 – Marking in unrestricted locations

Accessible hazard level	Required marking - Unrestricted location
1	No marking required
1M	No marking required ^{a)}
2	^{b)}  ^{e)} CAUTION HAZARD LEVEL 2 LASER ^{c)} RADIATION ^{d)} DO NOT STARE INTO BEAM
2M	^{b)}  ^{e)} CAUTION HAZARD LEVEL 2M LASER ^{c)} RADIATION ^{d)} DO NOT STARE INTO THE BEAM OR VIEW DIRECTLY WITH NON-ATTENUATING OPTICAL INSTRUMENTS
3R	Not permitted
3B	Not permitted
NOTE See 4.6.5 regarding invisible laser beam hazards.	
Conditions applicable to the above table: ^a Subclause 4.4.1 requires access to radiation from a connector to be limited to hazard level 1 by a suitable means and the mechanical design of the fibre cables must be consistent with the relevant standard within the IEC 60794 series (see 4.3). Therefore, hazard level 1M is exempt from marking requirements. ^b A2 Hazard symbol warning label according to IEC 60825-1, Figure 1. A2 ^c Where the source of the radiation is a light emitting diode, the word "Laser" above shall be replaced by "LED". ^d Replacing the word "Radiation" with "Light" for radiation in the range 400 nm to 700 nm is optional. ^e A2 Explanatory label (outline) according to IEC 60825-1, Figure 2. It is permitted for this outline to also encompass the hazard symbol according to IEC 60825-1, Figure 1. A2	

A1

Table 2 – Marking in Restricted Locations

Accessible hazard level	Required Marking - Restricted Location
1	No marking required
1M	Marking required only for those cases where the requirements for cable connectors in unrestricted locations are not met (see 4.4.1), but also see note 2 below: a)  d) CAUTION HAZARD LEVEL 1M LASER ^{b)} RADIATION ^{c)} DO NOT VIEW DIRECTLY WITH NON-ATTENUATING OPTICAL INSTRUMENTS
2	a)  d) CAUTION HAZARD LEVEL 2 LASER ^{b)} RADIATION ^{c)} DO NOT STARE INTO BEAM
2M	a)  d) CAUTION HAZARD LEVEL 2M LASER ^{b)} RADIATION ^{c)} DO NOT STARE INTO THE BEAM OR VIEW DIRECTLY WITH NON-ATTENUATING OPTICAL INSTRUMENTS
3R	a)  d) CAUTION HAZARD LEVEL 3R LASER ^{b)} RADIATION ^{c)} AVOID EXPOSURE TO THE BEAM
3B	Not permitted.
Text deleted	
NOTE 1 Where the accessible radiation at points of disconnection is hazard level 1 or hazard level 1M, it is permitted for this to be noted in information for the user instead of as a marking on (e.g.) the product, fibre or connector.	
NOTE 2 See 4.6.5 regarding invisible laser beam hazards.	
Conditions applicable to the above table: a) Warning label according to Figure 1 of IEC 60825-1. b) Where the source of the radiation is a light emitting diode, the word "Laser" above shall be replaced by "LED". c) If the radiation is in the range 400 nm to 700 nm it is optional to replace the word "Radiation" with "Light". d) Explanatory label (outline) according to Figure 2 of IEC 60825-1. It is permitted for this outline to also encompass the hazard symbol according to Figure 1 of IEC 60825-1.	

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