

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Safety of laser products –
Part 2: Safety of optical fibre communication systems (OFCs)
(standards.iteh.ai)

Sécurité des appareils à laser –
Partie 2: Sécurité des systèmes de télécommunications par fibres optiques
(STFO)

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Sécurité des appareils à laser –
Partie 2: Sécurité des systèmes de télécommunications par fibres optiques (STFO)

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SAFETY OF LASER PRODUCTS –

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

FOREWORD

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International Standard IEC 60825-2 has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

This fourth edition cancels and replaces the third edition published in 2004, Amendment 1:2006 and Amendment 2:2010. This edition constitutes a technical revision.

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

- a) Recommendations for individual components and subassemblies have been clarified; see Clause 1, paragraph 3.
- b) C_7 has been revised in accordance with IEC 60825-1:2014, but with an additional limitation related to the skin MPE; see 4.7.2.
- c) Condition 2 has been changed, and a detailed description of the measurement and determination method for hazard level has been added; see 4.7.1 and 4.7.2.
- d) Annex B has been moved into 4.9. Annex F has been moved forward as Annex B.
- e) Clause D.4 Hazard level evaluation examples – Additional examples have been added.
- f) Clause D.5 Fault analysis – Explanation and guidance has been simplified.

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

FDIS	Report on voting
76/670/FDIS	76/674/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 60825 series, published under the general title *Safety of laser products*, can be found on the IEC website.

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

- reconfirmed,
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INTRODUCTION

The objective of this document is to:

- protect people from optical radiation emitted by OFCSs;
- 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 OFCSs through the use of signs, labels and instructions.

Annex A gives a more detailed rationale for this document.

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, relevant safety information needs to be marked on the product or included within the instructions for use.

Where required by the level of potential hazard, the installation organization or end-user / operating organization or both are responsible for the safe deployment and use of OFCSs.

The installation organization and service organization are responsible for adherence to safety instructions during installation and service operations, respectively. The end-user or operating organization is responsible for adherence to safety instructions during operation and maintenance functions.

It is recognized that the user of this document can fall into one or more of the aforementioned categories of manufacturer, installation organization, end-user or operating organization.

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SAFETY OF LASER PRODUCTS –

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

1 Scope

This document provides requirements and specific guidance for the safe operation and maintenance of optical fibre communication systems (OFCSs). In these systems, optical power is possibly accessible outside the confines of the transmitting equipment and/or at great distance from the optical source.

This document requires the assessment of hazard level at each accessible location of the OFCS as a replacement for product classification according to IEC 60825-1. It applies to the installed OFCS as an engineered, end-to-end assembly for the generation, transfer and receipt of optical radiation arising from lasers, light-emitting diodes (LEDs) or optical amplifiers, in which the transference is by means of optical fibre for communication and/or control purposes.

NOTE 1 Throughout this document, a reference to 'laser' is taken to include LEDs and optical amplifiers.

Individual components and subassemblies that fall under the definition of a laser product are subject to the applicable subclause(s) of IEC 60825-1. This document is applicable to individual components and subassemblies intended to be installed within OFCSs.

This document 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, OFCSs possibly give rise to other hazards, such as fire.

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

NOTE 2 The hazard presented by optical radiation emerging from a fibre is determined by the wavelength and power emerging from the fibre and also by the optical characteristics of the fibre itself (see Annex A).

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*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

accessible location

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

feature of an OFCS whereby the accessible power is reliably reduced to a specified level within a specified time, whenever there is an event which could result in human exposure to radiation

Note 1 to entry: The term "automatic power reduction" (APR) used in this document encompasses the following terms used in ITU-T Recommendation G.664 [1]:

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

Note 2 to entry: The term automatic laser shut off (ALSO) has also been used by some manufacturers in the industry.

Note 3 to entry: A fibre-cable break is an example of an event which could result in human exposure to radiation.

3.3

end-user

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

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Note 1 to entry: The end-user cannot necessarily control the power generated and transmitted within the system.

Note 2 to entry: 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 defined in this document applicable to a manufacturer or installation organization.

3.4

hazard level

level of potential hazard at any accessible location within an OFCS

Note 1 to entry: It is based on the level of laser 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 defined in 5.3 in IEC 60825-1:2014. The meaning of hazard level is clarified in Annex B.

3.5

hazard level 1

hazard level at which, under a reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for hazard level 1 as defined in 4.7.2 a) and 4.7.3, will not exceed the accessible emission limits of Class 1 in IEC 60825-1 for the applicable wavelength and emission duration, with additional constraints as defined in 4.7.2 a)

Note 1 to entry: "Additional constraints" refers to additional and stricter constraints than 4.7.2 a) of this document places on the values specified in IEC 60825-1:2014 for the accessible emission limits of Class 1 in the wavelength range 1200 nm to 1400 nm.

3.6

hazard level 1M

hazard level at which, under a reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for hazard level 1M as defined in 4.7.2 a) and 4.7.3, will not exceed the accessible emission limits of Class 1 in IEC 60825-1 for the applicable wavelength and emission duration, with additional constraints as defined in 4.7.2 a)

Note 1 to entry: "Additional constraints" refers to additional and stricter constraints than 4.7.2 a) of this document places on the values specified in IEC 60825-1:2014 for the accessible emission limits of Class 1 in the wavelength range 1200 nm to 1400 nm.

3.7

hazard level 2

hazard level at which, under a reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for hazard level 2 as defined in 4.7.2 b) and 4.7.3, will not exceed the accessible emission limits of Class 2 in IEC 60825-1 for the applicable wavelength and emission duration

3.8

hazard level 2M

hazard level at which, under a reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for hazard level 2M as defined in 4.7.2 b) and 4.7.3, will not exceed the accessible emission limits of Class 2 in IEC 60825-1 for the applicable wavelength and emission duration

3.9

hazard level 3R

hazard level at which, under a reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for hazard level 3R as defined in 4.7.2 c) and 4.7.3, will not exceed the accessible emission limits of Class 3R in IEC 60825-1 for the applicable wavelength and emission duration, with additional constraints as defined in 4.7.2 c)

Note 1 to entry: "Additional constraints" refers to additional and stricter constraints than 4.7.2 c) of this document places on the values specified in IEC 60825-1:2014 for the accessible emission limits of Class 3R in the wavelength range 1200 nm to 1400 nm.

3.10

hazard level 3B

hazard level at which, under a reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for hazard level 3B as defined in 4.7.2 d) and 4.7.3, will not exceed the accessible emission limits of Class 3B in IEC 60825-1 for the applicable wavelength and emission duration

3.11

hazard level 4

hazard level at which, under a reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for hazard level 4 as defined in 4.7.2 e) and 4.7.3, will exceed the accessible emission limits of Class 3B in IEC 60825-1 for the applicable wavelength and emission duration

Note 1 to entry: This document is applicable for the operation and maintenance of OFCS. In order to achieve an adequate level of safety for persons who might come into contact with the optical transmission path, hazard level 4 is not permitted within this document. 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

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

**3.13
controlled location****location with controlled access**

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

Note 1 to entry: For examples, see D.2.1 a).

**3.14
restricted location****location with restricted access**

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 might not have laser safety training

Note 1 to entry: For examples, see D.2.1 b).

**3.15
unrestricted location
location with unrestricted access**

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

Note 1 to entry: For examples, see D.2.1 c).

**3.16
manufacturer**

organization or individual that constructs or modifies OFCSs by assembling or incorporating optical devices and other components

Note 1 to entry: Typical components in OFCSs are shown in D.2.2.
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**3.17
operating organization**

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

**3.18
optical fibre communication system
OFCS**

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**

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

Note 1 to entry: Examples of reasonably foreseeable events might include the following: fibre cable break, optical connector disconnection, operator error or inattention to safe working practices.

Note 2 to entry: Any intentional act to create a hazard is not considered as a reasonably foreseeable event.

**3.20
service organization**

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

3.21

subassembly

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

Note 1 to entry: The definition of subassembly is different from that of optical sub-assembly defined in IEC TS 62538 [2].

4 Requirements

4.1 General

Clause 0 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, such as an open connector or fibre break, etc. Whenever one or more alterations are made to an OFCS, the organization responsible for such alteration(s) shall determine whether each alteration could affect the originally assigned hazard level. If the originally assigned hazard level has changed, the organization responsible for the alteration(s) shall, if necessary, re-label those locations in the system that are accessible so as to ensure continued compliance with this document.

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 evaluated by the following methods depending on the types of the fibre cables.

- a) For a conventional loose tube fibre optic cable without ribbon fibre structures, the radiation shall be assessed individually from each of the fibres in a cable, and the maximum radiation from one fibre shall be used as the basis for the hazard level evaluation.
- b) For a ribbon fibre optic cable, the cumulative radiation from one flat ribbon fibre shall be assessed as either an extended source or a point source, as appropriate.

It is noted that there is no need to perform the complete evaluation for extended sources if the simplified point source analysis for the ribbon fibres results in a hazard level acceptable to the operating organization. Additionally, in order to perform the extended source analysis, it is necessary to know the radiation from each individual fibre in the ribbon. If this information is not available then a point source analysis using $C_6 = 1$ is applied.

Based on the determined hazard level, appropriate actions shall be taken to ensure compliance with this document. These actions could for example involve restriction of access to the location, or the implementation of additional safety features or redesign of the optical communications system to reduce the hazard level.

Visual observation of fibre tips using magnifying optics should be avoided in situations where there is potential for optical emission from the fibre.

Electric power transmitting cables comprising OFCSs with optical fibre cables defined in the IEC 60794-4 series [3]¹ shall meet the requirements of any applicable electrical standard besides this document.

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.

¹ Numbers in square brackets refer to the Bibliography.

4.3 Fibre cables

For all hazard levels, the fibre optic cable shall have mechanical properties appropriate to its physical location. Cables for various physical locations are described in the IEC 60794-2 series [4], IEC 60794-3 series [5] and IEC 60794-4 series [3]. Where necessary, additional protection, for example ducting, conduit or raceway, might be required for locations where the fibre would otherwise be susceptible to damage. Even if the potential hazard at any accessible location within an OFCS is the lowest hazard level, the mechanical properties need to be considered as optical power in fibre cable can exceed the MPE.

4.4 Cable connectors

4.4.1 General

The following requirements for cable connectors can 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.

Hazard level is required to be assigned more strictly for connectors than that for fibre cables. For example in an unrestricted location, accessible radiation level is allowed up to hazard level 1M for cables whereas the accessible radiation from an optical connector is limited to hazard level 1.

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

4.4.2 Unrestricted locations

In unrestricted locations,

- if the accessible radiation level exceeds hazard level 2 within the wavelength range 400 nm to 700 nm, then suitable means shall limit access to the radiation exceeding hazard level 2 from the connector,
- if the accessible radiation level exceeds hazard level 1 in all other cases, then suitable means shall limit access to the radiation exceeding hazard level 1 from the connector.

NOTE In an unrestricted location the highest hazard levels are hazard level 2M for the wavelength range 400 nm to 700 nm and hazard level 1M in all other cases (see 4.9.2).

4.4.3 Restricted locations

In restricted locations,

- if the accessible radiation level exceeds hazard level 2M within the wavelength range 400 nm to 700 nm, then suitable means shall limit access to the radiation exceeding hazard level 2M from the connector,
- if the accessible radiation level exceeds hazard level 1M in all other cases, then suitable means shall limit access to the radiation exceeding hazard level 1M from the connector.

NOTE In a restricted location the highest hazard level is hazard level 1M, 2M or 3R, whichever is the higher (see 4.9.3).

4.4.4 Controlled locations

In controlled locations,

- if the accessible radiation level exceeds hazard level 2M within the wavelength range 400 nm to 700 nm, then suitable means shall limit access to the radiation exceeding hazard level 2M from the connector,
- if the accessible radiation level exceeds hazard level 1M in all other cases, then suitable means shall limit access to the radiation exceeding hazard level 1M from the connector.

NOTE In a controlled location the highest hazard level is hazard level 3B (see 4.9.4).