

INTERNATIONAL STANDARD

IEC 60825-2

1993

AMENDMENT 1

1997-12

Amendment 1

Safety of laser products –

**Part 2:
Safety of optical fibre communication systems**

Amendement 1

Sécurité des appareils à laser –

*Partie 2:
Sécurité des systèmes de télécommunication
par fibres optiques*

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International Electrotechnical Commission
Telefax: +41 22 919 0300

3, rue de Varembé Geneva, Switzerland
e-mail: inmail@iec.ch IEC web site <http://www.iec.ch>



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

L

For price, see current catalogue

FOREWORD

This amendment has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

The text of this amendment is based on the following documents:

FDIS	Report on voting
76/162/FDIS	76/169/RVD

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

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Add the titles of the following two new annexes D and E as follows:

- D Application notes for the safe use of optical fibre communication systems
- E Bibliography

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Add, after annex C, the new annex D as follows:

Annex D (informative)

Application notes for the safe use of optical fibre communication systems

D.1 Introduction

This annex provides guidance on the application of IEC 60825-2 to specific practical situations. This annex applies to optical fibre communication systems (OFCS) where optical power is normally confined in a fibre and may be accessible at a great distance from the optical source. It does not apply to optical fibre systems primarily designed to transmit optical power for applications such as material processing or medical treatment.

It is an informative annex to assist OFCS operators in applying the requirements of IEC 60825-1 and IEC 60825-2 to their specific application. It does not contain any manufacturer or installer requirements.

D.2 Definitions

For the purpose of this annex D, the following definitions apply:

D.2.1

accessible location

a location anywhere in an optical fibre communications system where optical radiation might become accessible in reasonably foreseeable circumstances

D.2.2

FITs:

an indicator of reliability defined as the number of failures per 10^9 h

D.2.3

HITs

the number of hazard incidents per 10^9 h

D.3 Areas of application

D.3.1 Typical optical fibre installations

a) Locations with controlled access (see 3.13):

- cable ducts;
- street cabinets;
- manholes;
- dedicated and delimited areas of network operator distribution centres;
- test rooms in cable ships.

b) Locations with restricted access (see 3.14):

- secured areas within industrial premises not open to the public;
- secured areas within business/commercial premises not open to the public (for example telephone PABX rooms, computer system rooms, etc.);
- general areas within switching centres;
- delimited areas not open to the public on trains, ships or other vehicles;
- overhead fibre optic cables and cable drops to a building;
- optical test sets.

c) Locations with unrestricted access (see 3.15):

- domestic premises;
- industrial commercial or business premises;
- public areas on trains, ships or other vehicles;
- open public areas such as parks, streets, etc.

Distributed fibre networks may pass through unrestricted public areas (for example in the home), restricted areas within industrial premises, as well as controlled areas such as cable ducts or street cabinets.

OFCS Local Area Networks (LANs) may be deployed entirely within restricted business premises.

Fibre systems may be entirely in unrestricted domestic premises such as hi-fi interconnections.

Infra-red (IR) wireless LANS are outside the scope of this annex.

D.3.2 Typical hardware components

- a) Fibre cables: single/multiple/ribbon construction;
single/multimode;
carrying single/multiple wavelengths;
uni/bidirectional, fibre;
communications/power feeding.
- b) Optical sources: LEDs, communications lasers, pump lasers, optical amplifiers,
bulk/distributed, continuous/low/high-frequency emission.
- c) Connectors: permanent/semi-permanent, single/multiple.
- d) Power splitters, wavelength de/multiplexers, attenuators.
- e) Enclosures and protective housings.
- f) Fibre distribution frames.

D.3.3 Typical conditions

- a) Installation.
- b) Operation.
- c) Maintenance.
- d) Servicing.
- e) Fault.
- f) Measurement (including optical time domain reflectometry – OTDR).

D.4 Optical fibre power system limits

Mean power fibre limits for the laser classes are presented below at various wavelengths in the optical fibre. For most typical systems with duty cycles of between 10 % to 100 %, the peak power can be allowed to increase as the duty cycle decreases. However, for duty cycles of ≤ 50 %, it is most straightforward to limit the peak powers to twice these mean power limits, although IEC 60825-1 can be used for a more sophisticated analysis in order to identify any increase in peak powers permissible for these types of systems.

D.5 Hazard level evaluation examples

NOTE – For optical sources, enclosures and protective housings already classified according to IEC 60825-1 by the manufacturer, the hazard level according to IEC 60825-2 may be different from the classification according to IEC 60825-1. The reasons for these differences are:

- IEC 60825-2 has a hazard level $k \times 3A$ for restricted and controlled access situations;
- operator uses automatic power reduction (APR) for determination of the hazard level;
- results from fault analysis in IEC 60825-2 may be different from single fault analysis in IEC 60825-1.

D.5.1 Multiple wavelengths over the same fibre

When more than one wavelength is used on the same fibre, such as on a wavelength division multiplex system (WDM), then the hazard level depends on both the power levels and whether the wavelengths are additive. For skin exposure to wavelengths usually used in optical fibre communication systems, the hazards are always additive. For most fibre systems, 1 400 nm is the point at which addition conditions change:

- a) if two wavelengths are both below 1 400 nm they add, i.e. the combined hazard is higher;
- b) if two wavelengths are both above 1 400 nm they add, i.e. the combined hazard is higher;
- c) if one is above 1 400 nm, and one below, then retinal hazards do not add, i.e. the combined hazard does not increase.

It is necessary to calculate separately for skin and retinal hazards. To calculate the combined hazard level in a multi-wavelength system, it is necessary to calculate the system power at each wavelength as a proportion of the AEL for that class at that wavelength (for example 25 %, 60 %, etc. up to 100 %), and add together. If the totalled proportion exceeds 1 (100 %), then the hazard level exceeds that class.

Multi-wavelength example

An optical transmission system using multimode fibre of 50 micrometres core diameter and a numerical aperture $0,2 \pm 0,02$ carries six optical signals: at wavelengths of 840 nm, 870 nm, 1 290 nm, 1 300 nm, 1 310 nm and 1 320 nm. Each of these signals has a maximum time-averaged power of -8 dBm (0,16 mW). Determine the location hazard level at the transmitter site.

In the absence of any other information concerning the transmitter emission duration when a connector is removed, assume that no shut-down system operates, and classify on the basis of the power levels accessible at the transmitter connector (removing the connector is a reasonably foreseeable event).

Assess on the basis of:

- 100 s emission duration (see 9.3 e) of IEC 60825-1), and
- a minimum viewing distance of 100 mm (see 8.2 c) of IEC 60825-1).

Table 5 of IEC 60825-1 indicates that the effects of all wavelengths are additive. The evaluation must therefore be made on the basis of the ratio of the accessible emission at each wavelength to the AEL for the laser class at that wavelength (see 9.3b) of IEC 60825-1).

Note, however, that the AELs are constant in the wavelength range 1 200 nm to 1 400 nm; hence, the four signals in the vicinity of 1 300 nm may be considered as a single signal with a power level equal to the sum of powers in those signals.

First compare the emission levels with the AEL for class 1:

$$\begin{aligned} AEL_{840 \text{ nm or } 870 \text{ nm}} &= 7 \times 10^{-4} t^{0,75} C_4 C_6 \text{ J} \\ &= 7 \times 10^{-4} t^{-0,25} C_4 C_6 \text{ W} \end{aligned}$$

where $C_4 = 100,002(\lambda - 700)$

and for a point source, $C_6 = 1$

$$AEL_{1 \text{ 300 nm}} = 3,5 \times 10^{-3} t^{0,75} C_6 C_7 \text{ J} = 3,5 \times 10^{-3} t^{-0,25} C_6 C_7 \text{ W}$$

where $C_7 = 8$

hence $AEL_{840 \text{ nm}} = 0,42 \text{ mW}$

$AEL_{870 \text{ nm}} = 0,49 \text{ mW}$

$AEL_{1 \text{ 300 nm}} = 8,9 \text{ mW}$