Draft for Public Comment

Form 36

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Responsible committee: EPL/76 Optical radiation safety and laser equipment

Interested committees:

Title: Draft BS EN 60825-12 Amendment 1 - Safety of laser products. Part 12: Safety of free space optical communication systems used for transmission of information.

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

i) has any issues related to 3rd party IPR, patent or copyright
ii) affects other national standard(s)
iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at **https://standardsdevelopment.bsigroup.com/**. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex **(e.g. 3.1)**	Paragraph/Figure/ Table/Note	**Type of comment**	**Commend (justification for change) by the MB**	**Proposed change by the MB**	**Secretariat observations on each comment submitted**
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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76/631/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER: **IEC 60825-12/AMD1 ED2**	
DATE OF CIRCULATION: **2019-07-05**	CLOSING DATE FOR COMMENTS: **2019-08-30**
SUPERSEDES DOCUMENTS: **76/630/RR**	

IEC TC 76 : OPTICAL RADIATION SAFETY AND LASER EQUIPMENT	
SECRETARIAT: United States of America	SECRETARY: Mr William Ertle
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 108	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☒ SAFETY

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Safety of laser products - Part 12: Safety of free space optical communication systems used for transmission of information

NOTE FROM TC/SC OFFICERS:

This CD is being circulated for 8 weeks so as to have comments received for discussions at our upcoming Plenary Meeting in Raleigh, NC, from September 29 - October 4. The CC will be circulated immediately upon the closing of the CD, without the Observations of the Secretariat, so that National Committees can review the comments for Raleigh. A revised CC, with the Observations of the Secretariat, will be circulated approximately 30-days post Raliegh.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF LASER PRODUCTS –

Part 12: Safety of free space optical communication systems used for transmission of information

FOREWORD

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International Standard IEC 60825-12 has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

This Amendment 2.1 cancels and replaces the Ed 2.0 published in 2019. This Amendment constitutes a technical revision.

This Amendment 2.1 includes the following significant technical changes with respect to the previous edition 2.0:

a) The referenced document replaced IEC 60825-1: latest edition with IEC 60825-1: 2014.

b) Condition 2 replaced 7 mm aperture stop and 70 mm distance with 3,5 mm aperture stop and 14 mm distance.

c) C_7 has been revised in accordance with IEC 60825-1:2014, but with an additional limitation related by the Skin MPE; see 4.2.2.

d) Additional clarification added to 4.9 regarding the content and formatting of labels.

e) Annex A has been added for Rationale.

f) Annex B has been added for clarification of the meaning of "access level".

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g) Worked examples have been added for a variety of scenarios, see annexes C.1 to C.4.

h) Annex C.5 has been added on UAS, unmanned aerial systems.

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

FDIS	Report on voting
76/XX/FDIS	76/XX/RVD

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

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

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

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SAFETY OF LASER PRODUCTS –

Part 12: Safety of free space optical communication systems used for transmission of information

1 Scope

This part of IEC 60825 provides requirements and specific guidance for the manufacture and safe use of laser products and systems used for point-to-point or point-to-multipoint free space optical data transmission in the wavelength range from 180 nm to 1 mm. This part of IEC 60825 only addresses the open beam portion of the system. If portions of the equipment or system incorporate optical fibre that extends from the confinements of the enclosure(s), the manufacturing and safety requirements in IEC 60825-2 apply to those portions only. This standard does not apply to systems designed for the purposes of transmitting optical power for applications such as material processing or medical treatment. This standard also does not apply to the use of systems in explosive atmospheres (see IEC 60079-0).

Light-emitting diodes (LEDs) employed by free space optical communication systems (FSOCSs), used for the purpose of free space optical data transmission, do not fall into the scope of this standard. This standard covers lasers employed by FSOCSs used for the purpose of free space optical data transmission.

This part of IEC 60825:

- provides information to protect people from potentially hazardous optical radiation produced by FSOCSs by specifying engineering controls and requirements, administrative controls and work practices according to the degree of the hazard; and
- specifies requirements for manufacturing, installation, service and operating organizations in order to establish procedures and provide written information so that proper precautions can be adopted.

Because of the nature of FSOCSs, also known as optical wireless or free-air information transmission systems, care is taken in their manufacture as well as their installation, operation, maintenance and service to assure the safe deployment and use of these systems. This standard places the responsibility for certain product safety requirements, as well as requirements for providing appropriate information on how to use these systems safely, on the manufacturer of the system and/or transmitters. It places the responsibility for the safe deployment and use of these systems on the installer and/or operating organization. It places the responsibility for adherence to safety instructions during installation and service operations on the installation and service organizations as appropriate, and during operation and maintenance functions on the operating organization. It is recognized that the user of this standard may fall into one or more of the categories of manufacturer, installer, service organization and/or operating organization as mentioned above.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60825-1:2014, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 60825-2:2019, *Safety of laser products – Part 2: Safety of optical fibre communication systems*

3 Terms and definitions

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

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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
access level
potential hazard at any accessible position associated with a free space optical communication system (FSOCS) installation

Note 1 to entry: The access level is based on the level of optical radiation which could become accessible in reasonably foreseeable circumstances, e.g. walking into an open beam path. It is closely related to the laser classification procedure in IEC 60825-1.

Note 2 to entry: Practically speaking, it takes two or more seconds to fully align an optical aid with a beam (which might occur in an unrestricted location), and this delay is incorporated into the method for determining access level.

3.2
access level 1
assigned hazard at any accessible location within a FSOCS at which, under reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 1 as defined in 4.2 of this document, will not exceed the accessible emission limits of Class 1 for the applicable wavelengths and emission duration, with additional constraints as defined 4.2.2.2

Note 1 to entry: The “additional constraints” mentioned above refer to additional and stricter constraints that 4.2.2.2 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 to 1400 nm.

3.3
access level 1M
assigned hazard at any accessible location within a FSOCS at which, under reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 1M as defined in 4.2 of this document, will not exceed the accessible emission limits of Class 1 for the applicable wavelengths and emission, with additional constraints as defined 4.2.2.2

Note 1 to entry: The “additional constraints” mentioned above refer to additional and stricter constraints that 4.2.2.2 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 to 1400 nm.

Note 2 to entry: If the applicable limit of access level 1M is larger than the limit of access level 2 or 3R and less than the limit of access level 3B, access level 1M is allocated.

3.4
access level 2
assigned hazard at any accessible location within a FSOCS at which, under reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 2 as defined in 4.2 of this document, will not exceed the accessible emission limits of Class 2 for the applicable wavelengths and emission duration, with additional constraints as defined 4.2.2.3

3.5
access level 2M
assigned hazard at any accessible location within a FSOCS at which, under reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 2M as defined in 4.2 of this document, will not exceed the accessible emission limits of Class 2 for the applicable wavelengths and emission duration, with additional constraint as defined 4.2.2.3

Note 1 to entry: If the applicable limit of access level 2M is larger than the limit of access level 3R and less than the limit of access level 3B, access level 2M is allocated.

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3.6
access level 3R
assigned hazard at any accessible location within a FSOCS at which, under reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 3R as defined in 4.2 of this document, will not exceed the accessible emission limits of Class 3R for the applicable wavelengths and emission duration, with additional constraints as defied 4.2.2.4

Note 1 to entry: The "additional constraints" mentioned above refer to additional and stricter constraints that 4.2.2.4 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 to 1400 nm.

access level 3B
assigned hazard at any accessible location within a FSOCS at which, under reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 3B as defined in 4.2 of this document, will not exceed the accessible emission limits of Class 3B for the applicable wavelengths and emission duration

3.7
access level 4
assigned hazard at any accessible location within a FSOCS at which, under reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 4 as defined in 4.2 of this document, will exceed the accessible emission limits of Class 3B for the applicable wavelengths and emission duration

Note 1 to entry: This document is applicable for the operation and maintenance of FSOCS. In order to achieve an adequate level of safety for persons who may come into contact with the optical transmission path, access level 4 is not permitted within this document. It is permitted to use protection systems, such as automatic power reduction (APR, see 3.9) or installation protection system (IPS: see 3.16), to achieve the required access level where the transmitted power under any operating conditions (e.g. normal and fault operation) exceeds that permitted for a particular location type. For instance, it is possible for accessible parts of an FSOCS to be access level 1 even though the power transmitted down the free space under normal operating conditions is Class 4.

3.8
automatic power reduction
APR
feature of a transmitter of an FSOCS, provided by the system equipment manufacturer, by which the accessible power in the nominal hazard zone (NHZ) or extended nominal hazard zone (ENHZ) is reduced to a specified value within a specified time.

Note 1 to entry: 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).

Note 2 to entry: The accessible power in the NHZ or ENHZ is reduced to a specified value within a specified time, whenever there is an event which could result in human exposure to optical radiation above the maximum permissible exposure (MPE), e.g. by a person entering the NHZ or ENHZ, as applicable. In an FSOCS, this feature may be used by the transmitter manufacturer to determine the classification.

3.9
beacon
optical source whose function is to aid in pointing or alignment of an optical system

3.10
end-to-end system
FSOCS that is comprised of at least one transmitter, one receiver, and any peripheral hardware necessary for the effective transfer of data along the transmission path from one position in space to another

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3.11
extended nominal hazard zone
ENHZ
volume within which, when optical aids are used, the level of eye exposure to direct, reflected or scattered radiation exceeds the applicable maximum permissible exposure (MPE) as defined in IEC 60825-1

Note 1 to entry: Exposure levels outside the boundary of the ENHZ are below the applicable MPE when optical aids are used.

Note 2 to entry: This volume is determined prior to activation of any IPS or APR systems unless the APR is used for classification under the conditions of 4.5 of this standard.

3.12
free space optical communication system
FSOCS
installed, portable, or temporarily mounted, through-the-air system typically used, intended or promoted for voice, data or multimedia communications and/or control purposes via the use of modulated optical radiation produced by a laser

Note 1 to entry: "Free space" means indoor and outdoor optical wireless applications with both non-directed and directed transmission.

Note 2 to entry: Emitting and detecting assemblies may or may not be separated.

3.13
FSOCS transmitter
transmitter
optical transmitter emitting radiation through the air and used in an FSOCS

3.14
installation organization
installer
organization or individual who is responsible for the installation of an FSOCS

3.15
installation protection system
IPS
feature of an installation site, provided by the installer or operating organization, that has two functions: (1) it detects human entry into the accessible volume of either the NHZ for restricted or controlled locations or the ENHZ for an unrestricted location, and (2) once such entry is detected, causes reduction of the accessible power of the laser to a specified level within a specified time

3.16
interlock
means either of preventing access to a hazardous location until the hazard is removed, or of automatically removing the hazardous condition when access is gained

3.17
location
position or site occupied or available for occupancy

Note 1 to entry: Other standards may use the same terms for location types (3.19 – 3.22) with somewhat different definitions.

3.18
location of inaccessible space
inaccessible space
volume where a person cannot normally be located, i.e. the space that has a horizontal spacing more than 2,5 m from any unrestricted location and is both greater than 6 m above a surface in any unrestricted location, and more than 3 m above a surface in any restricted location

Note 1 to entry: Inaccessible space may be entered by, for example, aircraft.

Note 2 to entry: All open space that is neither an unrestricted, restricted nor controlled location.

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3.19
location with controlled access
controlled location
location where an engineering or administrative control measure is present to make it inaccessible except to authorized personnel with appropriate laser safety training

3.20
location with restricted access
restricted location
location that is normally inaccessible to the general public (including workers, visitors, and residents in the immediate vicinity) by means of any administrative or engineering control measure but that is accessible to authorized personnel (e.g. maintenance or service personnel including window cleaners in exterior locations) who may not have laser safety training

3.21
location with unrestricted access
unrestricted location
location where access to the transmission/receiver equipment and open beam is not limited (accessible to the general public)

3.22
manufacturer
organization or individual who makes or assembles optical devices and other components for the construction or modification of an FSOCS

3.23
nominal hazard zone
NHZ
volume within which the level of eye exposure to direct, reflected or scattered radiation exceeds the applicable maximum permissible exposure (MPE) as defined in IEC 60825-1.

Note 1 to entry: Exposure levels outside the boundary of the NHZ are below the applicable MPE.

Note 2 to entry: This volume is determined prior to activation of any IPS or APR systems unless the APR is used for classification under the conditions of 4.5 of this standard.

3.24
operating organization
operator
organization or individual who is responsible for the operation and maintenance of an FSOCS

3.25
optically-aided viewing
use of optical aids (for example, binoculars or magnifiers) to view an emitting source from within the emitted beam

Note 1 to entry: It is possible that telescopic optics, including binoculars, could increase the hazard to the eye by intrabeam viewing of a collimated beam when viewed at a distance.

3.26
removable laser system
laser system that can be removed from its protective housing and operate by simply plugging into electrical mains or a battery

3.27
primary beam
beam that transmits the modulated data signal

3.28
reasonably foreseeable event
event (or condition) that is credible and whose likelihood of occurrence (or existence) cannot be disregarded

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3.29
service organization
organization or individual who is responsible for the service of an FSOCS

3.30
special tool
tool that is not readily available at retail consumer hardware stores

Note 1 to entry: Typical tools in this category are intended for use with tamper-resistant fasteners.

3.31
spillover
beam radiant energy that propagates past the receiving terminal

3.32
transmit aperture
aperture portion of FSOCS which to be emitted the beam for transmit

3.33
without optical aids
optically unaided
without using magnifiers or other optical aids, as with the naked eye

Note 1 to entry: Prescription eyeglasses and contact lenses are not considered optical aids.

4 Requirements

4.1 General remarks

For FSOCSs employing lasers for the purpose of free space optical data transmission, product classification shall be made in accordance with IEC 60825-1.

If an FSOCS incorporates a removable laser system, that removable laser system shall comply with the applicable requirements of IEC 60825-1.

FSOCSs have limitations imposed by this standard that are dependent on the location type(s) in which they are installed. Product classification and access level restrictions by location type are summarized in Table 1.

In each location where emission is transmitted, crosses or is received, respective exposure conditions shall be individually evaluated. Furthermore, potentially occupied locations along the beam path, within the NHZ or ENHZ, shall also be evaluated for acceptable access levels (Table 1) and appropriate controls applied. Locations traversed by partial reflections from windows within the beam path shall also be evaluated if the emission could exceed access level 1 or 2. At a given location, the installation and operational constraints applied from 4.4 shall be determined by whichever is the more hazardous: the transmitted or the received optical radiation.

In the case of a location that receives access level 1 or 2 radiation but uses a access level 1M transmitter in the opposite direction, these combined conditions are acceptable for restricted locations but not for an unrestricted location unless the transmission equipment is installed as described in 4.4.2.2 to reduce the transmitter access level to 1 or 2.

For links with spillover beyond the receiver, but within the ENHZ that is of access level 1M or 2M, the spillover (and any accessible radiation otherwise outside of the receiver path, e.g. in front of it) must be contained within a restricted or controlled location, an unrestricted location compliant with 4.4.2.2, or inaccessible space.

For Class 3B and Class 4 transmitters in controlled locations, the entire beam path that potentially passes through other location types, including inaccessible space, must comply with the access level restrictions of Table 1. This may be satisfied in some applications by continually monitoring the entire NHZ to ensure rapid automatic power reduction in the event of human interception of the beam path. Any spillover beyond the receiver, (and any accessible radiation otherwise outside of the receiver path

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– e.g. in front of it), within the NHZ, must also be contained in a controlled location or inaccessible space. Any additional spillover within the ENHZ must be contained within a restricted or controlled location, an unrestricted location compliant with 4.4.2.2, or inaccessible space.

Table 1 – Restrictions for the use of FSOCS based on their access levels

Location Type	Permissive access levels	Additional installation controls
Unrestricted	Access level 1 or 2	None
	Access level 1M or 2M	See 4.4.2.2
	Access level 3R	See 4.4.2.3
	Access level 3B or 4	Shall not apply
Restricted	Access level 1, 2, 1M or 2M	None
	Access level 3R -	See 4.4.3.2
	Access level 3B or 4	Shall not apply
Controlled	Access level 1, 2, 1M, 2M or 3R	None
	Access level 3B or 4	See 4.4.4.2
Inaccessible space	Access level 1 or 2	None
	Access level 1M, 2M or 3R	See 4.4.5
	Access level 3B or 4	Shall not apply

The operating organization has the ultimate responsibility for the installation, maintenance, service and safe use of the end-to-end system including engineering and administrative controls. This includes, especially

- identification of the location type at all portions of the entire transmission path, including beam spillover outside the receiver collection area and partial reflections from intermediate windows, where people may have access;
- ensuring that the product classification, access level requirements, and installation conditions from Table 1 are satisfied for those location types;
- ensuring that installation, maintenance and service are performed only by organizations with the capability of satisfying the requirements of 4.4.

Requirements for transmitter manufacturers, installers and service organizations are also included in this standard.

IEC 60825-1 and IEC 60825-2 shall apply for classification and hazard level evaluations of FSOCSs employing lasers intended for transmission of data over fibre optic cable.

4.2 Determination of access level

4.2.1 General

Determination of access levels is the ultimate responsibility of the manufacturer and the operating organization. However, they may be determined by the maintenance, installation or service

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organization. The methods for determining compliance with an access level are the same as those described for classification in IEC 60825-1 except for the following.

a) The access level within a designated location shall be determined at any position relative to an FSOCS transmitter where the access level is maximized, and could depend on intermediate system elements such as windows.

b) The access level may depend on the activation of an IPS or APR system.

c) If an IPS or APR system is monitoring the location in question, during the 2 s immediately following any human interception, the accessible emission shall not exceed the MPE. Otherwise, the same method used for classification is also used for determination of access level. For viewing conditions without optical aids refer to the tables of MPEs in IEC 60825-1.

NOTE 1 Rationale for 2 s: Because of the difficulty of a person with binoculars or other optical aid to fully align with the beam, it is not reasonably foreseeable that a person could intercept the beam's full power within 2 s. During the 2-second period following exposure, no part of the body would be exposed above the optically unaided MPE for access levels of 1, 2, 1M, 2M or 3R.

NOTE 2 Exposure limits for the eye and the skin of employees in the workplace and the general public are in many countries specified in national laws. These legally-binding national exposure limits might differ from the MPEs given in the informative Annex A of IEC 60825-1 Ed. 3.0.

Verification testing of access levels shall be carried out under reasonably foreseeable single fault conditions to ensure that the APR and/or IPS, if used, is operating properly. In circumstances where it is difficult to carry out direct measurements, an assessment of the access level based on calculations may be acceptable. Faults which result in the emission of radiation in excess of the applicable AEL for a limited period only and for which it is not reasonably foreseeable that human access to the radiation will occur before the product is taken out of service or adjusted down below the AEL, need not be considered.

4.2.2 The use of Condition 2

4.2.2.1 General

The access level is determined by the measurement of the optical radiation that could become accessible following any reasonably foreseeable event during operation and maintenance.

All three conditions shall be tested. Condition 1 and Condition 3 shall be tested according to IEC 60825-1.

For all wavelengths, Condition 2 measurements to establish access levels shall be made with a 3,5 mm aperture at a distance of 14 mm from the end of the FSOCS transmitter (this simulates a ×18 magnifier).

In addition to the above, and for all wavelengths, the total emission from the FSOCS transmitter for Access Level 3B systems shall not exceed the AEL of Class 3B.

In circumstances where it is difficult to carry out direct measurements, an assessment of access level based on calculations is acceptable.

For an FSOCS with automatic power reduction, the access level will be determined by the accessible emission (pulse or continuous wave) after the time interval of 2 s. Additionally the MPE requirement in 4.3 shall be satisfied.

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