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Title:
IEC 62471-2 Ed.1: Photobiological safety of lamps and lamp systems – Part 2: Guidance on manufacturing requirements relating to non-laser optical radiation safety

(Titre) :

Introductory note

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Photobiological safety of lamps and lamp systems – Part 2:

Guidance on manufacturing requirements relating to non-laser optical radiation safety

FOREWORD

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IEC 62471-2, which is a technical report, has been prepared by technical committee 76: Optical radiation safety and laser equipment

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date[1] indicated on the IEC web site under

[1] The National Committees are requested to note that for this publication the maintenance result date is 2011.

"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- withdrawn;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.

This document which is purely informative is not to be regarded as an International Standard.

INTRODUCTION

This report was prepared by IEC TC76/WG9. The scope of IEC TC 76 (2004): *"…includes the preparation of standards applying limits as derived by organizations such as ICNIRP and CIE for human exposure to optical radiation (100 nm to 1 mm) from artificial sources…"* The IEC standard series 60825 ("Safety of Laser Equipment") addresses the specific hazards of lasers (and "laser-like" optical sources). From 1993 to 2007, the scope of IEC 60825-1 included LEDs. However, the application of the laser-related safety criteria and standards' philosophy led to an over-estimation of the real risk of injury as a result of exposure to optical radiation from LEDs in most applications where they are used. This consequently led to the removal of LEDs from the scope of that laser product standard.

Optical radiation hazards from all types of lamps or other broadband light sources are more appropriately assessed by the application of the IEC/CIE Standard 62471, Edition 1, 2006, *Photobiological Safety of Lamps and Lamp Systems*. IEC 62471 covers LEDs as well as incandescent, fluorescent, gas-discharge, arc and other lamps. The standard provides risk groups for all lamps and lamp systems, and the measurement conditions are well developed. IEC 62471 does not include manufacturing or user requirements that may be required as a result of a lamp or lamp system being assigned to a particular risk group. The safety requirements for lamp systems necessarily vary and are best dealt with in vertical standards. This part 2 provides the basis for safety requirements dependent upon risk group and examples thereof. The assigned risk group of a product may be used to assist with risk assessments, e.g. for occupational exposure in workplaces. National requirements may exist for the assessment of products or occupational exposure.

There are some instances where the IEC 60825 laser product standards may be useful for specialty lamps such as when LEDs are nearly monochromatic and mimic a point source, as in an LED fibre source or a super-luminescent diode (SLD).

1. Scope

This Technical Report provides the basis for non-laser optical radiation safety requirements of products, serving as a guide for developing safety requirements for vertical product standards and assisting lamp system manufacturers in the interpretation and application of safety (risk group) information as provided by the lamp and system manufacturer.

This report provide guidance on:

- requirements for optical radiation safety assessment;

- allocation of safety measures;
- labelling of products;
- suggestion for which standard should be applied to particular types of sources or applications.

This Technical Report does not address safety requirements of intentional exposure to optical radiation from sun tanning equipment, ophthalmic instruments or other medical/cosmetic devices whose specific safety issues are addressed through appropriate standards.

2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only addition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE Informative references are listed in the Bibliography

1. IEC 60417-1 *Graphical symbols for use on equipment*
2. IEC 60432-1 *Incandescent lamps - Safety specifications - Part 1: Tungsten filament lamps for domestic and similar general lighting purposes*
3. IEC 60432-2 *Incandescent lamps - Safety specifications - Part 2: Tungsten-halogen lamps for domestic and similar general lighting purposes*
4. IEC 60432-3 *Incandescent lamps - Safety specifications - Part 3: Tungsten-halogen lamps (non-vehicle)*
5. IEC 60825-1, *Safety of laser products - Part 1: equipment classification and requirements* IEC 61167 *Metal halide lamps*
6. IEC 61199 *Single-capped fluorescent lamps - Safety specifications*
7. IEC 62035, Ed 1.1 b: 2003 *Discharge lamps (excluding fluorescent lamps – Safety specifications*. (??)
8. IEC 62471:2006, *Photobiological safety of lamps and lamp systems*

3 Definitions

For the purposes of this Technical Report, the terms and definitions of IEC 62471 with the following additional definitions apply.

3.1
controlled access location
location where an engineering and administrative control measure is established to restrict access except to authorised personnel with appropriate safety training

3.2
Excess of optical radiation Hazard Values (EHV)
over applicable Exposure Limit Values is defined as:

$$\mathrm{EHV}(\text{distance}, \text{exposure time}) = \frac{\text{Hazard Value}(\text{distance}, \text{exposure time})}{\text{Exposure Limit Values}}$$

3.3
Exposure Limit Values (ELVs)
level of exposure of optical radiation to the eye or skin that is not expected to result in adverse biological effect. These ELVs are used to determine foreseeable safety distances in respect to photobiologicals effects.

3.4
hazard distance
minimum distance from the source at which the irradiance/radiance falls below the appropriate Exposure Limit Value (ELV)

3.5
intended viewing
deliberate act of an individual to either look at a source of optical radiation or at a virtual source, such as a reflection

3.6
intended use
usage of a product, process or service in accordance with specifications, instructions and information provided by the supplier

3.7
lamp
device emitting optical radiation in the wavelength range between 180 nm and 1 mm, with the exception of laser radiation

3.8
lamp system
product incorporating a lamp or lamps including fixtures, generally as intended by the manufacturer to be used (for visible applications: Luminaire). May include diffusers, enclosures and/or beam modifying optics

3.9
modifying optics
optical components, such as filters and reflectors, which change the characteristics of the optical radiation from a lamp when incorporated into a lamp system

3.10
physiological radiance
spatially averaged radiance, which may be lower than the source radiance

3.11
restricted access location
location which is normally inaccessible by the general public, including workers, visitors and residents in the immediate vicinity, by means of engineering or administrative control measures but is accessible to authorised personnel that may not have specific safety training

3.12
small source
source with an angular subtense smaller than the angle of acceptance γ which should be applied according to a risk assessment. This may result in the radiance of a source being averaged over a larger area than would be applied for the true radiance.

3.13
source radiance
physical radiance of the emitting element of the source

3.14
unintentional viewing
condition where optical radiation from a source enters the eye when such an exposure is not intended

3.15
unintentional skin exposure
condition where optical radiation from a source enters the skin when such an exposure is not intended

4 Requirements for Optical Radiation Safety Assessments

4.1 Basis for optical radiation safety assessment

The generally accepted criteria for the assessment of optical radiation hazards are the Guidelines issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Two sets of Exposure Limit Values (ELVs) are provided, separating laser and incoherent broadband sources. However, the principal hazard or damage mechanisms for coherent and incoherent optical radiation are not fundamentally different and the ELVs were derived from almost the same biophysical experimental base. The reason for differences between the laser limits and incoherent lamp exposure limits is the underlying consideration for human exposure: for laser radiation it is an exposure from the collimated point source under intra-beam viewing condition; whereas, for incoherent source it is usually an exposure from an extended source.

Safety requirements for lamps that emit potentially hazardous ultraviolet radiation have existed for decades, and requirements for safety labels and special marking are included in a number of lamp standards. A standardized method for assessing the risks posed by blue light and infrared radiant energy have been developed by the International Commission on Illumination (the CIE) working jointly with the IEC and resulting in the publication of CIE Standard S009 in 2002 (subsequently adopted as IEC 62471). The optical radiation safety criteria used in that standard were those of ICNIRP. An added impetus to develop these assessment criteria has been the dynamic development of semiconductor technology and optoelectronics that led to a wide variety of high intensity light-emitting diodes (LEDs). Although LEDs initially replaced only miniature (incandescent) lamps, today they are beginning to be used in general illumination.

4.2 Derived Product Safety Standards

The ICNIRP guidelines provide ***exposure*** limits and related measurement methods for the assessment of optical radiation hazards to the eyes and skin, where the exposure conditions and duration of exposure are determined by the individual (e.g., occupational hygienist) performing the risk assessment. However, for product safety standards it is necessary to determine the ***emission*** of the source; the measurement conditions are fixed based upon a reasonably foreseeable exposure condition. These do not necessarily vary substantially with the intended use conditions.

To give a user guidance on potential risks from optical radiation (e.g. in work places or for product manufacturers using the lamps), it is desirable to allocate optical sources into hazard categories known as risk groups, somewhat similar to hazard classification used with lasers. The risk groups in IEC 62471 indicate the degree of risk from potential hazards and minimise the need for further measurements.

The standardized measurement conditions consider the emission spectrum and either irradiance at a given distance for the assessment of some hazards or radiance (brightness of the source) to determine eye and skin hazards. The measurement conditions are related to potentially hazardous viewing conditions and take into consideration physiological factors of the eye, such as accommodation, pupil size, the

aversion response and eye movements (saccades). The measurement conditions are independent of the condition of use, except for general lighting sources (GLS), where the measurements are performed related to a reference level of illumination of 500 lux.

IEC 62471 does not provide guidance on manufacturing requirements and control measures.

4.3 Allocation of sources and applications

There may be a small number of applications where an incoherent optical radiation source should be considered within a laser safety standard framework (see Figure 1). Examples of such lamp systems include very small, nearly point sources: super-luminescent diodes which resemble “point sources”; and LEDs which are employed in optical fibre communications, where the fibre source also resembles a very small, or “point” source. The user is referred to IEC 60825-2 for optical fibre communication systems.

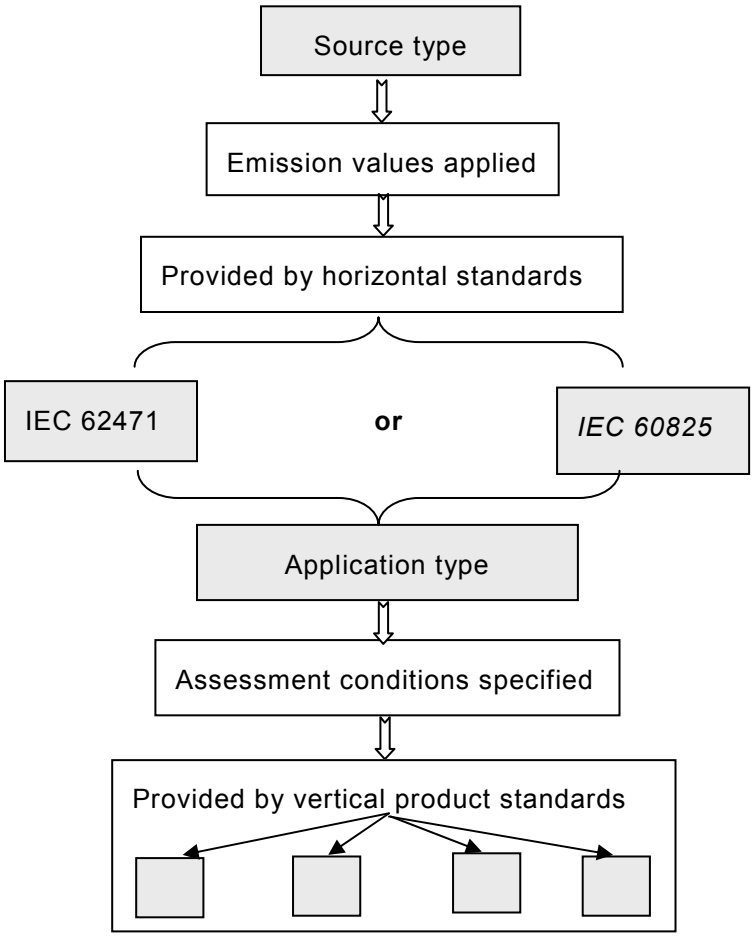

Figure 1 – Allocation by source type

IEC 62471 distinguishes between lamps intended for general lighting services (GLS) and other lamps intended for use in applications such as for germicidal, heating, signalling or data transfer. Assessment and measurement conditions are different for these two groups:

- GLS - the hazard values should be reported as irradiance or radiance values at a distance which produces an illuminance of 500 lux;

- Other applications – the hazard values should be reported at a distance of 200 mm from the source.

Different product groups define a range of operational, maintenance and servicing conditions. If the assessment applied to different product groups in vertical standard justify, the measurement conditions in IEC 62471 can be modified.

The requirements in the vertical standard may limit the source risk group that can be used in a given application, may require a specific performance based upon the risk group specifications, or may specify application-specific control measures.

Following this generic approach, the allocation of laser and lamp systems should not create any ambiguity.

5 Guidelines for lamp and lamp system manufacturers on how to apply IEC 62471

5.1 General

It should be noted that the risk group classification system of IEC 62471 is applied to both lamps and lamp systems. However, the lamp system manufacturer has responsibility for assessing the final product. It is possible that the lamp system or luminaire manufacturer may have limited capabilities for tests and measurement. Therefore, they may have to rely on data provided by the lamp manufacturer. Where the risk assessment for the eye is based on radiance (or time-integrated radiance), the Law of Conservation of Radiance may be used with caution. Integrating the lamp into a system should result in either the same radiance or a reduced radiance. Where the assessment is based on irradiance or radiant exposure, such assumptions cannot be made.

The transferability of the risk groups from the lamp to the lamp system may be limited. It may also be the case that the assessment criteria used to determine the risk group is not appropriate for the final application. These issues need to be addressed through vertical standards, taking account of IEC 62471 and this Technical Report.

Due to the above considerations the following requirements of the standard are essentially application-related and must therefore be considered by the final lamp system or luminaire manufacturer:

- The possible hazard of sources for general lighting service (GLS) shall be assessed at a specific distance which corresponds with an illuminance level of 500 lux

- Applications which require long term exposure to IR sources with weak or without visual stimulus in low ambient light environments (luminance less than 10 cd m^{-2}) are to be assessed with specific limit values where the radiance is averaged or the angular subtense of the source is limited..

- An additional limit set in the infrared spectral region is originally only related to applications of large IR-radiators with a significant amount of radiation emitted in the infrared - to protect (the cornea or lens of the eye) against long term thermal effects (e.g. cataract). Thus, it should only apply where the application is likely to result in chronic and lengthy exposures of the eye for periods greater than 1000 s and the daily averaged exposure would be expected to be at least 100 W m^{-2}. The primary objective is to minimise needless exposure.

Limits that are provided in IEC 62471 in terms of irradiance (at least outside the wavelengths range from 400 to 1400 nm) are basically related to the final product i.e. lamp system. As pointed out above, the assessment conditions in general should be preferably application (i.e. lamp system) related and provided by vertical standards.

Thus, the applicable emission limits as well as the related measurement conditions shall be specified in these vertical standards. Vertical standards should be guided by the principle that it may not be necessary to reduce optical radiation exposure to as low as reasonably achievable: needless exposures should be minimised.

In this respect, lamp system may consist of a single bare lamp or lamp(s) with or without integrated beam modifying optics. If the same lamp is employed with additional integrated/attached beam shaping or projection optics, this lamp system should be considered as a different product and the manufacturer should provide the new risk group safety classification. Risk groups of a single lamp and lamp system employing this particular lamp may be different: risk could increase or decrease. A high risk group lamp may be integrated into an exempt risk group lamp system by, for example, filtering of unwanted excessive optical radiation, shielding the source to prevent access to optical radiation by the eye directly or employing beam expanding optics. Alternatively, exempt group lamps may be combined into a lamp array fitted with collimating or focusing means and result in a higher risk group product.

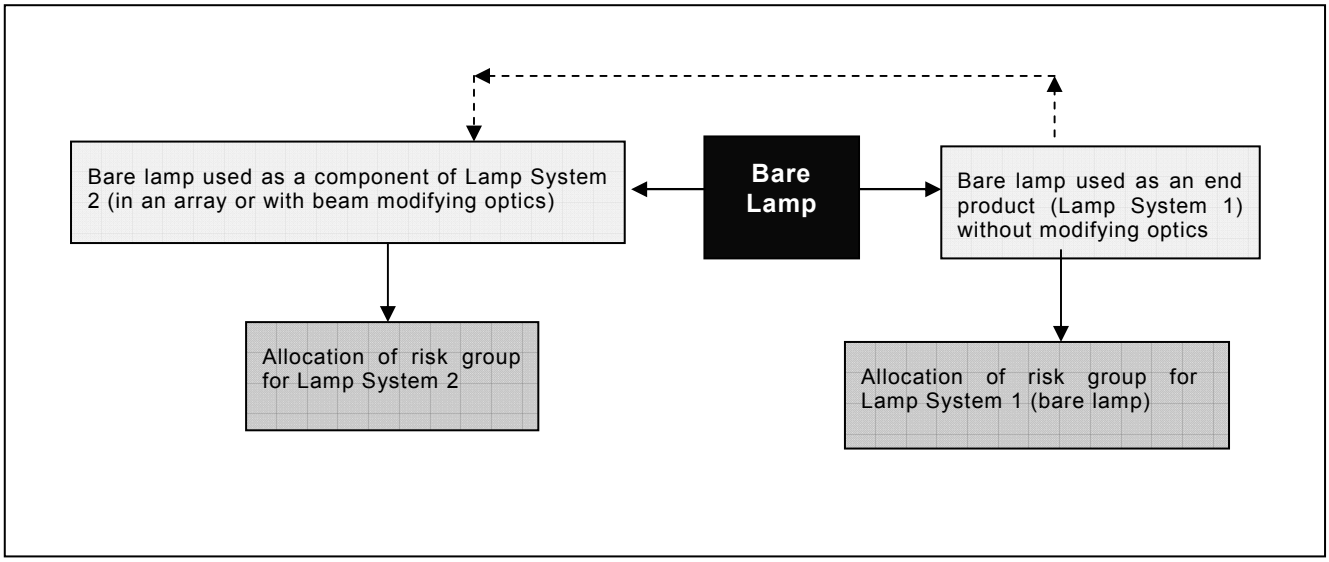

Figure 2 – Assignment of Risk Group

In the case of a lamp used as a lamp system without modifying optics, the assessments and risk group allocations of the lamp manufacturer are transferable to the final lamp system or luminaire. This may not be valid for a lamp system built up of two or more lamps. In such cases, the data provided by the lamp manufacturer cannot always easily be transferred to the lamp system and the manufacturer has to perform their own assessments and assign the system to the appropriate risk group. However, consideration of the risk group of the individual lamp should assist with the assessment.

Risk group categories should be used for the allocation of safety control measures to reduce potential exposure to optical radiation. Exposure to optical radiation should be reduced, as far as reasonably practicable, by controlling unwanted radiation at source, e.g. by spectral filtering and by preventing human access by enclosures.

5.2 Guidelines for lamp manufacturers on what information should be provided to the lamp system manufacturer

There are many types of lamps where the future application is known. For instance, in conjunction with conventional light sources, the modifications of the safety-relevant optical features of the incorporated lamp by the lamp system manufacturer are generally not significant. In most cases there is just one single conventional lamp (light bulb) used for a luminaire and the lamp system manufacturer for example adds only a fixture and a power supply etc. Such systems have to be considered also as case 1 lamp systems (see figure 2). In these clear cases, the lamp data are transferable to the lamp system and the

lamp manufacturer should perform the assessment and risk grouping. Information on risk group classification and possible hazard distance should be given for the foreseeable and intended use.

In case of multi-purpose lamps and small sources (see 3.11), and as long as application-related vertical standards do not exist and in order nevertheless to provide support for the case 2 lamp system manufacturer (see figure 2), the following should be provided by the lamp/LED manufacturer in cases of doubt about the future application:

- Limits provided in radiance or time-integrated radiance: according to the spectra of the lamp/LED the “true” radiance values should be determined (LEDs: at maximum ratings), however, spectrally weighted with the action functions B(λ) and R(λ) – if applicable. In this context, the “true” radiance means the conventional way of measuring radiance/luminance was applied for the determination - regardless of the possibly required field of view i.e. the source extends beyond the measurement area (see also definition 3.11).

- Limits provided in irradiance or radiant exposure: as pointed out above, these values are actually related to the lamp system and the final application as well. The measurement of a single lamp or component cannot be transferred at all for case 2 lamp systems (see figure 2). However, in order to determine the possible most restrictive hazard in comparison to the radiance-related limit, these measurements should be performed according to IEC 62741.

- The measurements of single lamps/LEDs by the manufacturer should be performed at a distance of 200 mm.

These values should be reported in the user information – at best with a classification note that these values would correspond with risk group x (which can be transferred to the risk group allocation of the final lamp system, provided that no changes in emission characteristics are made).

5.3 Guidelines for lamp system manufacturers on how to apply IEC 62741 to lamp systems

The lamp data as provided by the lamp manufacturer are not transferable in every situation; this is limited to lamp systems of case 1 (see figure 2). For case 1, the applied/assumed conditions have to be verified (unchanged source, without additional beam-shaping optics, etc). In all other situations the manufacturer of the (case 2) lamp system or luminaire has to carry out the assessment and assign the lamp system to the appropriate risk group. As pointed out above, the application of some exposure limits sets or assessment conditions as required for allocation to a risk group strictly depends on the final application.

5.3.1 Sources for General Lighting Service (GLS)

The IEC 62471 standard states that for lamps and lamp systems used for GLS, the hazard values should be reported as irradiance or radiance values at a distance which produces an illuminance of 500 lux. Only lamps and lamp systems which are classified as an exempt risk group concerning the skin hazard when assessed at the location of the 500 lux illuminance level can be used for GLS applications.

The required illuminance measurement of the GLS lamp systems takes into account contributions from all the elements of the lamp system. In contrast to the radiance measurement for risk group determination, the acceptance angle for the illuminance measurement of GLS sources is not limited.

Lamp manufacturers produce a few lamp types only for GLS-applications and these products should be classified by the lamp manufacturer only under GLS conditions. If

these sources are modified or used for purposes other than GLS, the lamp system (luminaire) manufacturer should perform the re-assessment and assign the appropriate risk group.

5.3.2 Small sources and Lamp systems of case 2

As pointed out in paragraph 5.1 in these situations the values of the “true” radiance or irradiance of the (single) bare source should be available as provided by the lamp manufacturer. These values should have been determined at a distance of 200 mm.

- Data provided in radiance or time-integrated radiance: the spectrally weighted values of the “true” radiance or time-integrated radiance can be compared with the applicable limit values for risk group categorisation. In situations where they already do not exceed the desired/required risk group limits, no further actions are necessary. Otherwise, worst-case-estimations, based for instance on the number of (small) sources within the applicable field of view (FOV), can be performed to calculate a radiance value which is to be compared with the risk group limits.

- Data provided in irradiance or radiant exposure: the data for a single bare source is not always directly transferable to the lamp system if the true source radiance is considerably larger than the physiological radiance As with GLS-sources, the required measurement of the lamp systems should take into account contributions from all the elements (lamps) of the lamp system.

5.4 Determination of the Hazard Distance

In order to be independent of the use condition, the risk group classification of lamps and lamp systems is based on worst case assumptions of exposure duration, pupil size and viewing distance. However, the spatial emission of lamps is often divergent and the viewer-related risk at a reasonable distance may not be adequately reflected by the risk classification of the equipment.

The information on Excess of optical radiation Hazard Values (EHV) over applicable Exposure Limits has significant practical importance. It is defined as:

$$\mathrm{EHV}(\text{distance}, \text{exposure time}) = \frac{\text{Hazard Value}(\text{distance}, \text{exposure time})}{\text{Exposure Limit Values}}$$

and gives guidance on appropriate control measures: either to limit the exposure duration or the accessibility of a source.

The distance where the optical radiation hazard value equals the applicable Exposure Limits Value is the Hazard Distance: exposure conditions are not restricted by behaviour limitations.

The EHV may be graphically presented as distance-dependent values: with increasing distance from a lamp or lamp system the applicable hazard values decrease - see figure 3. At the distance X1, EHV =1, i.e. the hazard value equals the applicable Exposure Limit. Distance X1 is the Hazard Distance for this lamp system. At distance X2, the optical radiation hazard value exceeds the applicable Exposure Limit by factor of A. At this distance, excessive exposure to optical radiation may be reduced either by restricting exposure time by factor of A, or by using engineering (filters) and personal protective means (eyewear, clothing) which attenuate the accessible emission of the lamp system.

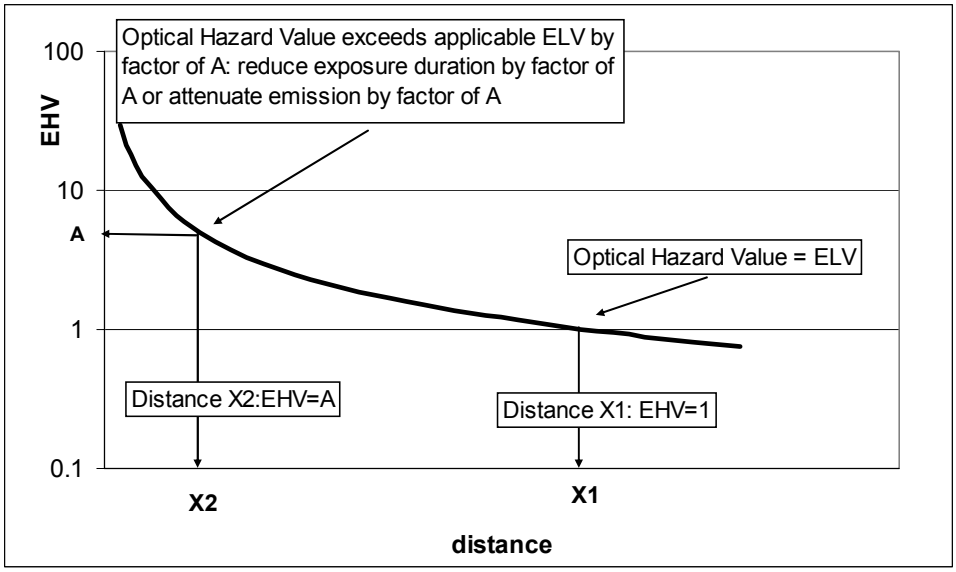

Figure 3 – Example of graphic presentation of distant dependent Excess of optical radiation Hazard Values.

Similar to the risk group allocation of the lamp or lamp system, these hazard distance values can also be categorized in order to determine the effective viewer-related risk under realistic use conditions. For instance, with increasing distance from a "high-risk" lamp system (as categorised at a measurement distance of 200 mm) the risk for the intended/accidental viewer will stepwise decrease from "moderate" (e.g. at x2 in figure 3) to "low" (e.g. at x1 in figure 3) to "exempt" - at those distances where the irradiance - or from where the measured radiance - falls below the applicable risk-group-specific emission limit. Therefore, in addition to assigning a lamp system to a risk group, the lamp system manufacturer should also provide such data. Where the lamp system is assigned to a risk group above exempt, the manufacturer should at least provide the Hazard Distance (HD) for all risk groups below the assigned one. These risk group-related hazard distances can be used for the determination of applicable safety measures, see table 3.

A more general solution can be provided for the lamp system-manufacturer; if the emission limits for the HD-determinations are used when expressed as a function of the exposure duration - as they are given by IEC 62471. With the resulting time-dependent HD a (graphically presented) relationship can be established between the maximum exposure duration and the HD. With the help of such a lamp system-specific graph, the user of the lamp system can decide on appropriate safety measures - e.g. either to limit the exposure duration or the accessibility of a source.

The lamp system manufacturer should provide the optical radiation safety data with the user information.

5.5 Labelling

Lamp systems should be marked by the manufacturer in accordance with the requirements of Table 1. Except for exempt and risk group 1 lamp system emitting only in the wavelength range 400 nm to 780 nm, the risk group should be marked on the product or, alternatively, on the package. Warning symbols should be in accordance with IEC 60417-1.

Labels should be permanently fixed, legible, and clearly visible during operation, maintenance and service. They should be positioned so that they can be read without the necessity for human exposure to optical radiation in excess of the applicable ELVs. Text and borders should be black on a yellow background. The label size should be adapted

to the size of the product. Reproductions of all required labels should be included in the operation manual.

Table 1. Requirements for hazard-related risk group labelling of lamp systems.

Hazard	Exempt Group	Risk Group 1	Risk Group 2	Risk group 3
Ultraviolet hazard 200-400 nm	Not required	CAUTION. UV emitted from this product. Minimise exposure to eyes or skin	CAUTION. UV emitted from this product. Eye or skin irritation may result from exposure	WARNING. UV emitted from this product. Avoid eye and skin exposure
Retinal blue light hazard 300-400 nm	Not required	Invisible radiation emitted from this product	CAUTION. UV emitted from this product	WARNING. UV emitted from this product. Avoid eye and skin exposure
Retinal blue light or thermal hazard 400-780 nm	Not required	Not required	CAUTION. Do not stare at operating lamp	WARNING. Do not look at operating lamp
Cornea/Lens Infrared hazard 780-3000 nm	Not required	CAUTION. IR emitted from this product	CAUTION. IR emitted from this product. Do not stare at operating lamp	WARNING. IR emitted from this product. Avoid eye exposure
Retinal thermal hazard, weak visual stimulus 780-1400 nm	Not required	CAUTION. IR emitted from this product	CAUTION. IR emitted from this product. Do not stare at operating lamp	WARNING. IR emitted from this product. Do not look at operating lamp

When a lamp or lamp system emits optical radiation from more than one hazard spectral region, it should be classified for the most restrictive case. If the optical radiation in other spectral regions exceeds the limits for exempt risk groups, appropriate warning should be included on the product label. For example, for a lamp assigned to Risk Group 3 on the basis of a retinal IR hazard and emitting UV to the level of Risk Group 2, the legend of the label should indicate Risk Group 3, with the appropriate 'Warning' text; and show the 'Caution' text for the Risk Group 2 for the UV, but should not mention Risk Group 2 explicitly, as illustrated in figure 4.

RISK GROUP 3

WARNING IR emitted from this product. Avoid eye exposure

CAUTION. UV emitted from this lamp. Skin or eye irritation may result from exposure

Figure 4 – Example of warning label for a lamp with multiple hazard spectral regions

5.6 Other information requirements

For the lamps and lamp systems in excess of the exempt group the following information should be provided:

a) clear statement that the lamp or lamp system is in excess of the exempt group and that the viewer-related risk is dependent upon how the users install and use the product;

b) the most restrictive optical radiation hazard and other optical radiation hazards in excess of exempt risk group;

c) Excess of optical radiation Hazard Values (EHV) values and the Hazard Distance with optional graphical presentation of distant-dependent EHV;

d) For lamps or lamp systems assigned to a risk group above exempt: Hazard Distances (HD) for all viewer-related risk groups below the assigned one.

e) adequate instructions for proper assembly, installation, maintenance and safe use, including clear warnings concerning precautions to avoid possible exposure to hazardous optical radiation;

f) advice on safe operating procedures and warnings concerning known malpractices, malfunctions and hazardous failure modes. Where maintenance procedures are detailed, they should wherever possible include explicit instructions on safe procedures to be followed.

g) reproduction of the labelling required in 5.4 and an explanation of its meaning shown in Table 2

Table 2. Explanation of labelling information and guidance on control measures

Hazard	Exempt Group	Risk Group 1	Risk Group 2	Risk group 3
Ultraviolet hazard 200-400 nm	Invisible radiation emitted from this product	CAUTION. UV emitted from this product. Minimise exposure to eyes or skin. Use appropriate shielding	CAUTION. UV emitted from this product. Eye or skin irritation may result from exposure. Use appropriate shielding	WARNING. UV emitted from this product. Avoid eye and skin exposure to unshielded product
Retinal blue light or thermal hazard 400-780 nm	Not required	Not required	CAUTION. Do not stare at operating lamp. May be harmful to the eyes	WARNING. Do not look at operating lamp. Eye injury may result
Retinal blue light or thermal hazard 400-780 nm	Not required	Not required	CAUTION. Do not stare at operating lamp. May be harmful to the eyes	WARNING. Do not look at operating lamp. Eye injury may result
Cornea/Lens Infrared hazard 780-3000 nm	Invisible radiation emitted from this product	CAUTION. IR emitted from this product. Use appropriate shielding or eye protection	CAUTION. IR emitted from this product. Do not stare at operating lamp. Use appropriate shielding or eye protection	WARNING. IR emitted from this product. Avoid eye exposure
Retinal thermal hazard, weak visual stimulus 780-1400 nm	Invisible radiation emitted from this product	CAUTION. IR emitted from this product. Do not stare at operating lamp	CAUTION. IR emitted from this product. Do not stare at operating lamp	WARNING. IR emitted from this product. Do not look at operating lamp

6 Allocation of safety measures

6.1 General

The manufacturer of the lamp or lamp system should perform a risk analysis to determine necessary safety measures and residual risks for the user, necessary warning and proposed user safety precautions. The risk group classification assists the manufacturer in the design of engineering controls to achieve an acceptable level of safety of the lamps and lamp systems. The type of product and its intended use determines an acceptable level of emission, foreseeable exposure duration and foreseeable accessible distances.

Exposure to optical radiation should be reduced by controlling unwanted radiation at source, e.g. by spectral filtering or by enclosures. Undesired hazardous UV and IR

radiation should be avoided where possible, or attenuated by appropriate filters. Selective control of unintentional spectral components in the visible spectral range can be more challenging because spectral filtering may cause change to essential colour or intensity of the lamp system.

The manufacturer should provide the user safety information and what type of user controls can be considered. Depending on product application, required control measures may include restricted and controlled access areas.

Restricted access locations are those areas that are inaccessible by the general public but they are accessible by authorised personnel that may not have specific training. Examples of interior restricted access areas are: equipment cabinets in locked/dedicated rooms, locations occupied by service/maintenance personnel, and areas requiring equipment such as specialist access towers. Allocation of restricted access areas is product-specific and should be addressed by product vertical standards.

Controlled access locations are those areas that are normally inaccessible except to authorised personnel with appropriate safety training. Examples of controlled access areas include locked rooms with strictly-controlled access, fenced/secure areas, interior areas of equipment requiring specialist tools for access. Allocation of controlled access areas is product-specific and should be addressed by product vertical standards.

In general, training, restricting access to a hazard zone and personal protective equipment can only be considered for professional use products used under work place conditions and if other controls are inadequate or impractical. Safety of specific product types should be addressed in corresponding vertical standards.

6.2 Maximum acceptable viewer-related risk

A viewer-related risk from a lamp or lamp system depends on the application of the product. The applications can be divided into three groups, according to the likelihood of intra-beam viewing of the source:

- Unintentional short term (automotive, spot, flash, projection);
- Intentional short term (laboratory, home, signalling);
- Intentional (or likely) long term (some toys and displays).

Note: limited to eye-hazards - chronic exposure (GLS) excluded

Guidance on the use of lamp and lamp systems of different risk groups for specific applications is provided in Table 3.

Table 3: maximum acceptable viewer-related risk group of lamp systems (uncapitalized italics) per application, (preferably inherently or e.g. by keeping within the corresponding HD) and risk group of the incorporated lamp (left column in capital letters).

likelihood for direct source viewing: (application group) → lamp risk group (hazards and time bases) ↓	unintentional short- term (automotive, spot, flash, projection…)	occasional (laboratory, home, signalling…)	intentional long- term (toys, displays, backlighting,…)
EXEMPT Act. UA*: 30000s Near-UV*: 1000s RBL: 10000s RT: 10s	no requirements	no requirements	no requirements

IR cornea/lens: 10^4s			
RISK GROUP 1 Act. UV*: 10000s Near-UV*: 300s RBL: 100s RT: 10s IR cornea/lens: 100s	no requirements	no requirements	***exempt*** (min. distance) or access control
RISK GROUP 2 Act. UV*: 1000s Near-UV*: 100s RBL: 0.25s RT: 0.25s IR cornea/lens: 10s	no requirements	***risk group 1*** (min. distance and/or max. exposure) or Restricted location	***exempt*** (min distance) or access control
RISK GROUP 3	***risk group 2*** (min. distance) or Restricted location	***risk group 1*** (min. distance and/or max. exposure) or Controlled location	***exempt*** (min. distance) or access control

Table 3 is for guidance. Application-related vertical standards may provide more details of the required assessment and specify safety control measures to be considered.

Contrary to the viewer-related measures, the safety measures for personnel in service and maintenance should depend solely on the risk group of the incorporated lamp - independent on the application of the lamp system.