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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Safety in installations for electroheating and electromagnetic processing – Part 12: Particular requirements for infrared electroheating

Sécurité dans les installations destinées au traitement électrothermique et électromagnétique – Partie 12: Exigences particulières pour chauffage électrique par rayonnement infrarouge

IEC 60519-12:2016-12(en-fr)

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SAFETY IN INSTALLATIONS FOR ELECTROHEATING AND ELECTROMAGNETIC PROCESSING –

Part 12: Particular requirements for infrared electroheating

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International Standard IEC 60519-12 has been prepared by IEC technical committee 27: Industrial electroheating and electromagnetic processing.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

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

a) the structure has been redrafted according to IEC 60519-1:2015;
b) terms/definitions, normative references and bibliography have been updated and completed;
c) all requirements and content from IEC 60519-12:2013 that have been included in IEC 60519-1:2015 have been removed to avoid any duplication.

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

CDV	Report on voting
27/967/CDV	27/982/RVC

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 60519 series, published under the general title *Safety in installations for electroheating and electromagnetic processing*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The clauses of parts of the IEC 60519 series (hereinafter called Particular Requirements) supplement or modify the corresponding clauses of IEC 60519-1:2015 (*General Requirements* hereinafter called Part 1).

This part of IEC 60519 is to be read in conjunction with Part 1. It supplements or modifies the corresponding clauses of Part 1. Where the text indicates an "addition" to or a "replacement" of the relevant provision of Part 1, these changes are made to the relevant text of Part 1. Where no change is necessary, the words "This clause of Part 1 is applicable" are used. When a particular subclause of Part 1 is not mentioned in this part, that subclause applies as far as is reasonable.

Additional specific provisions to those in Part 1, given as individual clauses or subclauses, are numbered starting from 101.

NOTE The following numbering system is used:

- subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;
- unless notes are in a new subclause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
- additional annexes are lettered AA, BB, etc.

In this standard, the following print types are used:

- requirements and definitions: in roman type;
- NOTES: in smaller roman type;
- terms used throughout this standard which have been defined in Clause 3: **in bold type**.

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INTRODUCTION

The scope of this standard covers a broad range of types and designs of infrared equipment which are used for many different purposes. This standard is intended to cover all industrial infrared equipment types, with some few exceptions provided in Clause 1.

Many other types of electroheating equipment emit infrared radiation of hazardous levels, therefore IEC 60519-1:2015 provides all general requirements addressing optical radiation and this document provides specific considerations for infrared equipment and helpful methods.

With reference to IEC 60519-2:2006 it has been agreed in TC 27 that this standard covers all kinds of infrared emission hazards of industrial electroheating installations and provisions not given in IEC 60519-1:2015.

The discussion of infrared radiation assessment has become quite detailed in this standard, as for the industry there is not any single useful source available for simple, versatile, easy to use and cost effective measurement methods.

The other principles for covering the risks caused by infrared radiation were:

- the manufacturer usually does not employ an expert in optical radiation measurement or has access to an optical laboratory with all the necessary equipment needed for elaborate measurements;
- operating staff with limited experience in radiation measurement is usually responsible for the task of performing the necessary measurements and will appreciate a simple and easy to follow guide;
- the scope of IEC 62471:2006 is limited to lamps but is applicable for other light sources. Therefore, core aspects were adapted from that standard and if possible simplified for this document.
- figures illustrating the classes defined in IEC 62471:2006 and listed in IEC 60519-1:2015 are included;
- relevant documents of American National Standard Institute/Illuminating Engineering Society of North America, the ANSI/IESNA RP 27 series, are based on the ICNIRP recommendations as well. They provide no extra or contradictory material with regard to this standard and its references.

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SAFETY IN INSTALLATIONS FOR ELECTROHEATING AND ELECTROMAGNETIC PROCESSING –

Part 12: Particular requirements for infrared electroheating

1 Scope and object

1.1 Scope

This clause of Part 1 is replaced by the following.

Replacement:

This part of IEC 60519 specifies safety requirements for industrial electroheating equipment and installations in which infrared radiation – usually generated by infrared emitters – is significantly dominating over heat convection or heat conduction as means of energy transfer to the workload. A further limitation of the scope is that the infrared emitters have a maximum spectral emission at longer wavelengths than 780 nm in air or vacuum, and are emitting wideband continuous spectra such as by thermal radiation or high pressure arcs.

IEC 60519-1:2015 defines infrared as radiation within the frequency range between 400 THz and 300 GHz. This corresponds to a wavelength range between 780 nm and 10 μm in vacuum. Industrial infrared heating commonly uses thermal infrared sources with rated temperatures between 500 °C and 3 000 °C; the emitted radiation from these sources dominates in the wavelength range between 780 nm and 10 μm.

Since substantial emission of thermal emitters can extend either to wavelengths below 780 nm or above 3 000 nm, the safety aspects of emitted visible light and emission at wavelengths longer than 3 000 nm are also considered in this document.

This standard is not applicable to:

- infrared installations with lasers or light-emitting diodes (LEDs) as main sources – they are covered by IEC 62471:2006 and IEC 60825-1:2014;
- appliances for use by the general public;
- appliances for laboratory use – they are covered by IEC 61010-1:2010;
- electroheating installations where resistance heated bare wires, tubes or bars are used as heating elements, and infrared radiation is not a dominant side effect of the intended use, covered by IEC 60519-2:2006;
- infrared heating equipment with a nominal combined electrical power of the infrared emitters of less than 250 W;
- handheld infrared equipment.

Industrial infrared electroheating equipment under the scope of this standard typically uses the Joule effect for the conversion of electric energy into infrared radiation by one or several sources. Radiation is then emitted from one or several elements onto the material to be treated. Such infrared heating elements are in particular:

- thermal infrared emitters in the form of tubular, plate-like or otherwise shaped ceramics with a resistive element inside;
- infrared quartz glass tube or halogen lamp emitters with a hot filament as a source;

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- non insulated elements made from molybdenum disilicide, silicon carbide, graphite, iron-chromium-aluminium alloys, refractory metals or comparable materials;
- wide-spectrum arc lamps.

1.2 Object

This clause of Part 1 is applicable.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60519-1:2015, *Safety in installations for electroheating and electromagnetic processing – Part 1: General requirements*

3 Terms, definitions and abbreviations

This clause of Part 1 is applicable except as follows.

Addition:

3.1 General concepts

3.1.101
infrared radiation
optical radiation for which the wavelengths are longer than those for visible radiation

Note 1 to entry: The infrared radiation range between 780 nm and 1 mm is commonly subdivided into:

IR-A 780 nm to 1 400 nm, or for a grey emitter 3 450 °C to 1 800 °C surface temperature;

IR-B 1 400 nm to 3 000 nm, or for a grey emitter 1 800 °C to 690 °C surface temperature;

IR-C 3 000 nm to 1 mm, or for a grey emitter less than 690 °C surface temperature.

The temperature corresponds to a spectrum where maximum intensity is at the wavelength of the limit.

These ranges comply with IEC 62471:2006.

Note 2 to entry: In IEC 60050-841:2004, the following terms are defined:

841-24-04 – shortwave infrared radiation or near infrared radiation (780 nm to 2 μm);

841-24-03 – mediumwave infrared radiation or medium infrared radiation (2 μm to 4 μm);

841-24-02 – longwave infrared radiation or far infrared radiation (4 μm to 1 mm).

These terms are not used in this standard.

[SOURCE: IEC 62471:2006, 3.14, modified – Note 1 has been modified and Note 2 added]

3.1.102
infrared heating
heating consisting in absorption of thermal and optical radiation, mostly infrared radiation, emitted by especially constructed equipment

[SOURCE: IEC 60050-841:2004, 841-24-05, modified – The definition has been editorially improved.]

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3.2 Equipment and state of equipment

3.2.103
infrared installation
infrared electroheating installation
electroheating installation, where processing of the workload is achieved by infrared heating

[SOURCE: IEC 60050-841:2004, 841-24-09, modified – The synonym has been added and the definition has been shortened.]

3.2.101
infrared emitter
component from which infrared radiation is emitted

Note 1 to entry: This component is usually replaceable.

3.2.102
infrared source
part of the infrared emitter, where electric energy is converted by the Joule effect into heat or radiation

3.2.103
filament
conductive wire or thread of an infrared emitter, in which electric energy is converted into heat by the Joule effect

[SOURCE: IEC 60050-841:2004, 841-24-27, modified – The definition has been clarified.]

3.2.104
infrared ceramic heater
infrared emitter made of or covered with ceramic material

[SOURCE: IEC 60050-841:2004, 841-24-13, modified – The definition has been shortened.]

3.2.105
tubular infrared emitter
infrared emitter in which one of the basic dimensions is dominant

Note 1 to entry: The emitter can include reflecting means and be straight or bent.

[SOURCE: IEC 60050-841:2004, 841-24-24, modified – The definition has been shortened and Note 1 has been added.]

3.2.106
infrared plate emitter
infrared emitter in which two of the basic dimensions are dominant

Note 1 to entry: The emitter can include reflecting means and can be flat or curved.

[SOURCE: IEC 60050-841:2004, 841-24-25, modified – The definition has been shortened and Note 1 has been added.]

3.2.107
infrared quartz emitter
infrared emitter in which the source is inside a quartz glass envelope

Note 1 to entry: Glass envelopes made from hard glasses comparable to quartz glass are included.

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[SOURCE: IEC 60050-841:2004, 841-24-26, modified – The definition has been shortened and Note 1 has been added.]

3.2.108
halogen lamp emitter
infrared emitter with a tungsten filament placed inside a gas tight glass envelope with halogen, containing atmosphere where the halogen actively transports tungsten from the glass wall to the tungsten filament

[SOURCE: IEC 60050-841:2004, 841-24-22, modified – The definition has been clarified.]

3.2.109
infrared reflector
passive, non transmitting component which reflects and directs infrared radiation

Note 1 to entry: The reflector can be part of an infrared emitter and can cause specular or diffuse reflection or a combination of both.

3.2.110
infrared refractor
passive, transmitting component that focuses and directs infrared radiation

Note 1 to entry: The refractor can be part of an infrared emitter.

3.2.111
wavelength converter
element inside the infrared installation that is heated up by infrared radiation during normal operation to a temperature, where its own emitted radiation participates in heating up the workload

Note 1 to entry: The spectrum of a wavelength converter has a substantially longer wavelength than the wavelength of major emission of the infrared emitters.

3.2.112
infrared module
component housing one or more infrared emitters

Note 1 to entry: The module can include reflectors, refractors, filters, or other means for protecting the emitter as well as cooling devices.

3.2.113
rated temperature
maximum surface temperature of the infrared filament or infrared emitter at rated voltage

Note 1 to entry: This temperature is used for the determination of the spectral emission of thermal infrared emitters.

Note 2 to entry: The temperature applies under conditions of normal operation.

3.3 Parts and accessories

3.3.101
filter
partially transparent, partially absorbing or reflecting component, designed to reduce transmission at selected wavelength

4 Classification and sub-division

This clause of Part 1 is applicable.

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5 Risk assessment

This clause of Part 1 is applicable with the following addition:

Addition:

NOTE 101 Annex AA provides additional information about a procedure for risk reduction from infrared radiation with the specific focus on projects with a shared design responsibility between manufacturer and user.

6 General provisions

This clause of Part 1 is applicable.

7 Protection against electric shock

This clause of Part 1 is applicable.

8 Protection against hazards caused by electric or magnetic nearfields

This clause of Part 1 is applicable.

9 Protection against hazards from radiation

This clause of Part 1 is applicable with the following addition:

Addition:

9.101 Protective measures against infrared radiation

9.101.1 General aspects

Technical measures to reduce exposure to infrared radiation include:

- The installation of suitable shields to reduce or avoid the emission of visible or infrared radiation from the equipment. This includes sufficient infrared enclosure (i.e. housing) of the infrared equipment. Shields and housing can become dangerously hot to the touch, if no sufficient measures are taken.
- Positioning of the radiation source so that no or only reduced radiation is directed towards persons.
- Suitable filters reduce the emission of infrared radiation emitted from the infrared electroheating equipment. Absorbing filters can become dangerously hot surfaces to touch.

Organisational measures are suitable during commissioning or maintenance work only, they include:

- Limiting access by physical means. Installation of infrared barriers to hinder access to areas with high radiation.
- Reducing exposure time of persons.
- Placement of suitable warning signs.
- Instruction of the operating staff in the hazards of infrared radiation and in the use of suitable protective measures.
- Use of personal protective measures and equipment.

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- Use of suitable clothing and gloves for the protection of the skin.
- Use of suitable glasses and filters for the protection of the eyes. Filters shall reduce the dangerous level of emission, without impairing the needed visual information.

NOTE Measures to reduce exposure include avoidance of exposure through the use of another heating method (see ISO 12100:2010). As most other heating methods generate infrared radiation that reach similar infrared intensity as infrared electroheating itself, avoidance is usually not possible through this measure.

9.101.2 Access points in the infrared enclosure

As part of the routine maintenance or setting of an installation, it can be necessary to measure the intensity or intensity distribution inside the infrared equipment, or to inspect the workload visually, or to inspect the inside of the equipment visually. If there is a need for access to the inside of the equipment or to the infrared radiation inside of the equipment, access points in the infrared enclosure shall be included during the design stage. The construction of access points shall not create emission of radiation above the level specified in the design targets.

To reduce emission through access points, the following measures shall be considered:

- they can be sealed by a door, which shall be able to open only with a tool, or
- they can have a window that shall include an infrared filter reducing the emission from that access point to a safe level.

9.101.3 Design of shields

Wherever possible, the infrared radiation shall be enclosed to prevent inadvertent access to levels of radiation above the design target level. The design of enclosure and shields depends on how these components are to be used including whether they will be removable or fixed and if they will require maintenance.

The equipment and the materials used for the attenuation of radiation shall withstand all effects of the environmental and operating conditions expected at intended use as well as during fault conditions. These factors include the climate, chemical and biological factors, the atmosphere near and inside the equipment (dust, vapours, and flammability), effects from periodic cleaning, and mechanical factors like vibration.

When applicable, the following requirements for the infrared enclosure and shields shall be fulfilled:

- the infrared emitter(s) shall be positioned so that the enclosure cannot be damaged by normal operation or any single fault condition which would lead to a change in the emission characteristics. If necessary, further mechanical protection shall be provided in order to achieve this;
- the emitter(s) shall be securely mounted. Normal operation or single fault conditions shall not cause them to dislodge;
- if the opening of a shield, a barrier or part of the enclosure gives an automatic "stop" command, the closing of the respective shield, barrier or enclosure shall not reactivate the emission without a further operation;
- the design of the enclosure and the mount(s) shall facilitate infrared emitter replacement without significant exposure to the operator;
- any further mechanical protection shall not increase the radiation emission hazard or other hazards by virtue of its presence or location;
- all detectors and indicators, the power source, all shields, shutters, and interlocks shall operate in a "fail to safety" mode.

9.101.4 Removing of shields

If the design target levels of radiation exposure will be exceeded when shields are removed

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- the emitters shall be automatically switched off, or
- mechanical shutters or other means used to restrict the emissions to the design target levels shall hinder emission.

If this is not possible, then the shield shall

- have fastenings which require a tool to release them, and
- suitable permanent warnings signs shall be affixed to them.

If shields or parts of them are designed to be removed for maintenance, the arrangement of fasteners shall ensure correct replacement.

10 Protection against hazards from thermal influences

This clause of Part 1 is applicable.

11 Protection against hazards from fire

This clause of Part 1 is applicable.

12 Protection against hazards from fluids

This clause of Part 1 is applicable.

13 Specific requirements for components and subassemblies

This clause of Part 1 is applicable.

14 Control of the installation or equipment

This clause of Part 1 is applicable.

15 Protection against mechanical hazards

This clause of Part 1 is applicable.

16 Protection against hazards resulting from use

This clause of Part 1 is applicable.

17 Protection against other hazards

This clause of Part 1 is applicable.

18 Verification and testing

This clause of Part 1 is applicable with the following addition:

Addition:

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18.101 Considerations and methods for measurements of infrared radiation

The measurement of optical radiation for the purpose of computing photo-biological radiation values poses significant challenges. Spectral irradiance or radiance measurements using a monochromator or spectrometer are difficult to make in the infrared due to a lack of simple or cost effective equipment made for industrial applications.

As no weighting function is defined at wavelengths greater than 1 400 nm, broadband measurements are suitable in evaluating those infrared hazard conditions that have no weighting function to consider. If the cumbersome measurement of spectrally resolved data and application of weight functions is not undertaken, either the maximum value of the weight function may be used over the complete wavelength range, or the measurement method of Annex BB. This measurement method does not need spectrally resolved measurements in the infrared, but still takes weight functions into account.

All hazard values shall be reported

- at a distance of 100 mm from the equipment, if the equipment is freely accessible, or
- if access is restricted, at all exposed and accessible positions.

The measurement equipment shall be oriented, to capture the highest signal.

NOTE Visually black surfaces can be reflective to infrared radiation.

The infrared equipment shall be operated under conditions that generate the maximum radiation emission from the equipment within normal operating conditions; single fault conditions being excluded. If different conditions during normal operation for different phases of the life cycle ensue, all of these need to be tested if possible:

- in case of equipment that is operated with or without workload, both cases shall be considered;
- in case of equipment that runs cyclic, all phases of a cycle shall be considered;
- in case of equipment with doors opening and closing during processing, open and closed states shall be considered.

For a simplified measurement method that uses a broad band detector as the sole measurement device, use Annex BB.

If Annex BB of this standard is used as measurement method, it shall supplement 5.2 and 5.3 of IEC 62471:2006.

19 Information for use

This clause of Part 1 is applicable.

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Annex A
(informative)

List of significant hazards

Annex A of Part 1 is applicable.

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Annex B
(informative)

Electric and magnetic fields, touch currents – limits of exposure hazards

Annex B of Part 1 is applicable with two additional notes in B.1.3.

B.1.3 Hazard sources and hazard effects

Addition

NOTE 101 Electric and magnetic fields generated by infrared electroheating are usually below relevant hazard levels.

NOTE 102 Ceramics and glasses become conductive at elevated temperatures thus providing the possibility of touch voltages.

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Annex C
(informative)

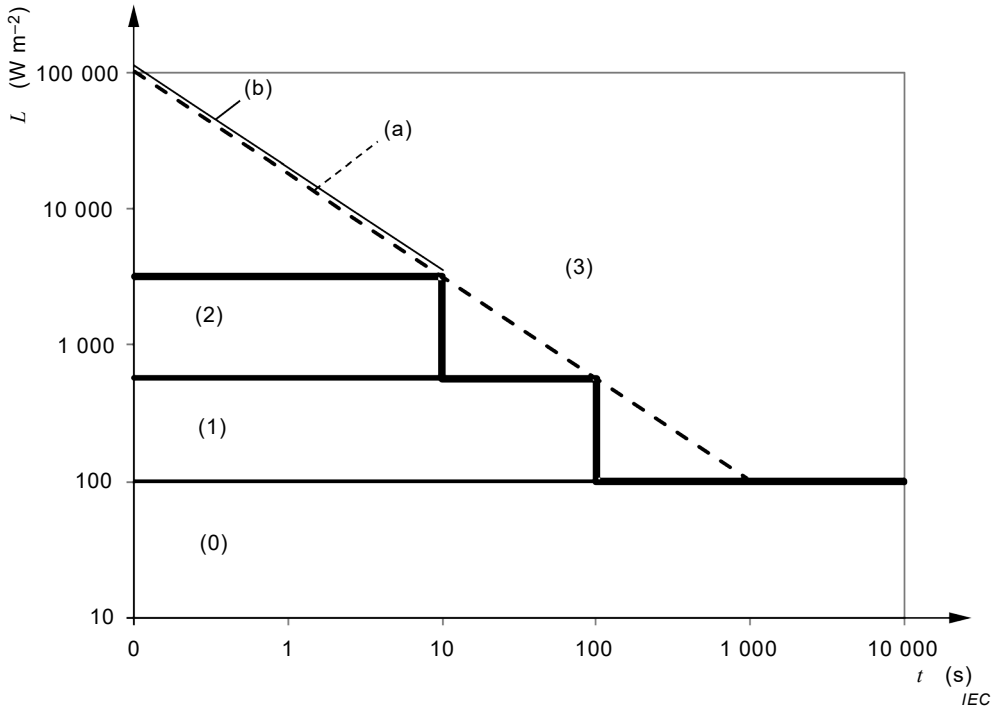
Optical radiation – limits of exposure hazards

Annex C of Part 1 is applicable, except where modified by the following.

Additions:

Figure C.101 illustrates the exposure limits from Table C.1 of IEC 60519-1:2015 and the risk groups for the hazards of burning of the skin and burning of the cornea caused by exposure to high irradiation.

Figure C.102 illustrates the exposure limits from Table C.2 of IEC 60519-1:2015 and the risk groups for the hazard of retinal burn caused by exposure to high radiation with visual stimulus.



Key

(0)	Exempt group	(a)	Exposure limit for the eye
(1)	Low risk group	(b)	Exposure limit for the skin
(2)	Moderate risk group		
(3)	High risk group		

Figure C.101 – Risk groups and exposure limits (refer to Table C.1 of IEC 60519-1:2015) depending on time of exposure and irradiation

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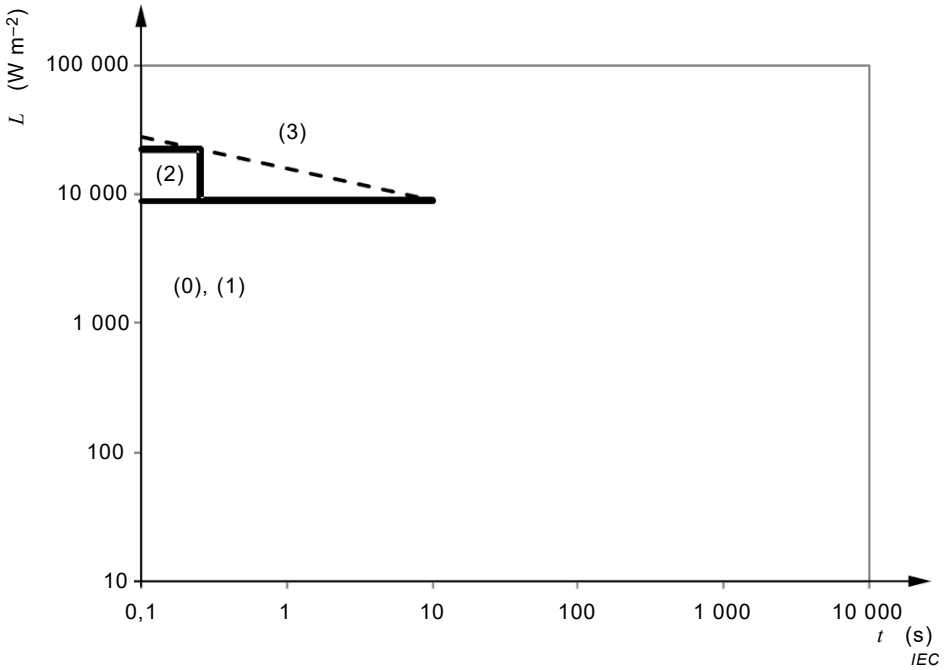

Key

(0)	Exempt group	(2)	Moderate risk group
(1)	Low risk group	(3)	High risk group

NOTE Angular subtense of the source is not included.

Figure C.102 – Risk groups and exposure limits (refer to Table C.2 of IEC 60519-1:2015) depending on time of exposure and radiance

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Annex D
(informative)

Limits for exposure hazards – noise and vibration

Annex D of Part 1 is applicable.

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Annex E
(normative)

Provisions concerning EMC

Annex E of Part 1 is applicable.

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