IEC TR 62778

Edition 2.0 2014-06

TECHNICAL REPORT

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Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires

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APPLICATION OF IEC 62471 FOR THE ASSESSMENT OF BLUE LIGHT HAZARD TO LIGHT SOURCES AND LUMINAIRES

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IEC TR 62778, which is a technical report, has been prepared by subcommittee 34A: Lamps, of IEC technical committee 34: Lamps and related equipment.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition: inclusion of the photobiological assessment of LED arrays (Annex D).

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The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
34A/1737/DTR	34A/1758/RVC

Full information on the voting for the approval of this technical report 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 committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site 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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of July 2014 have been included in this copy.

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APPLICATION OF IEC 62471 FOR THE ASSESSMENT OF BLUE LIGHT HAZARD TO LIGHT SOURCES AND LUMINAIRES

1 Scope

This Technical Report brings clarification and guidance concerning the assessment of blue light hazard of all lighting products which have the main emission in the visible spectrum (380 nm to 780 nm). By optical and spectral calculations, it is shown what the photobiological safety measurements as described in IEC 62471 tell us about the product and, if this product is intended to be a component in a higher level lighting product, how this information can be transferred from the component product (e.g. the LED package, the LED module, or the lamp) to the higher level lighting product (e.g. the luminaire).

A summary of recommendations to assist the consistent application of IEC 62471 to light sources and luminaires for the assessment of blue light hazard is given in Annex C.

NOTE It is expected that HID and LED product safety standards will make reference to this Technical Report.

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 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>).

IEC 62471:2006, *Photobiological safety of lamps and lamp systems*

CIE S 017/E:2011, *ILV: International Lighting Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62471:2006, CIE S 017/E:2011 and IEC 60050-845 as well as the following apply.

3.1
blue light hazard efficacy of luminous radiation
$K_{B,v}$
quotient of blue light hazard quantity to the corresponding photometric quantity

Note 1 to entry: Blue light hazard efficacy of luminous radiation is expressed in W/lm.

Note 2 to entry: The quantity $\Phi_\lambda(\lambda)$ in the formula below can be replaced by $L_\lambda(\lambda)$ or $E_\lambda(\lambda)$.

$$K_{B,v} = \frac{\int \Phi_\lambda(\lambda) \cdot B(\lambda) \cdot d\lambda}{K_m \cdot \int \Phi_\lambda(\lambda) \cdot V(\lambda) \cdot d\lambda}$$

where K_m = 683 lm/W.

Note 3 to entry: $K_{B,v} = L_B/L = E_B/E$.

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3.2
blue light hazard efficiency of radiation
η_B
ratio of blue light hazard quantity to the corresponding radiometric quantity

Note 1 to entry: The quantity $\Phi_\lambda(\lambda)$ in the formula below can be replaced by $L_\lambda(\lambda)$ or $E_\lambda(\lambda)$.

$$\eta_B = \frac{\int \Phi_\lambda(\lambda) \cdot B(\lambda) \cdot d\lambda}{\int \Phi_\lambda(\lambda) \cdot d\lambda}$$

3.3
correlated colour temperature
CCT
temperature of the Planckian radiator having the chromaticity nearest the chromaticity associated with the given spectral distribution on a diagram where the (CIE 1931 standard observer based) u', 2/3 v' coordinates of the Planckian locus and the test stimulus are depicted

Note 1 to entry: Correlated colour temperature is expressed in kelvin (K).

Note 2 to entry: The concept of correlated colour temperature should not be used if the chromaticity of the test source differs more than $\Delta C = [(u'_t - u'_p)^2 + \frac{4}{9}(v'_t - v'_p)^2]^{1/2} = 5 \times 10^{-2}$ from the Planckian radiator, where

u'_t, v'_t refer to the test source, u'_p, v'_p to the Planckian radiator.

Note 3 to entry: Correlated colour temperature can be calculated by a simple minimum search computer program that searches for that Planckian temperature that provides the smallest chromaticity difference between the test chromaticity and the Planckian locus, or e.g. by a method recommended by Robertson, A. R. "Computation of correlated color temperature and distribution temperature", J. Opt. Soc. Am. 58, 1528-1535, 1968. (Note that the values in some of the tables in this reference are not up-to-date).

[SOURCE: CIE S 017/E:2011, 17-258, modified — T_{cp} is not referenced.]

3.4
illuminance <at a point of a surface>
E
quotient of the luminous flux $d\Phi$ incident on an element of the surface containing the point, by the area dA of that element

Note 1 to entry: Illuminance is expressed in lm/m^2 or lx.

[SOURCE: IEC 60050-845:1987, 845.01.38, modified — The second half of the definition is omitted.]

3.5
blue light weighted irradiance
E_B
irradiance spectrally weighted with the blue light spectral weighting function as defined in IEC 62471

Note 1 to entry: Blue light weighted irradiance is expressed in W/m^2.

3.6
threshold illuminance
E_{thr}
threshold illuminance value, below which the light source can never give rise to an exposure time $t_{max} < 100$ s, regardless of the light source's L_B value

Note 1 to entry: The threshold illuminance can be calculated by taking the E_B value for $t_{max} = 100$ s, which is $E_B = 1$ W/m^2, and dividing E_B by the $K_{B,v}$ value corresponding to the spectrum of the light source.

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Note 2 to entry: Threshold illuminance is expressed in lm/m^2 or lx.

3.7
etendue
geometrical property of a collection of light rays in an optical system, given by the integral over all positions in a plane that these light rays pass through and over all directions into which they travel

Note 1 to entry: It takes the form of a product of area and solid angle. It can be seen as a volume in phase space. Basic physical conservation laws, related to the 'second law of thermodynamics', dictate that optical components that change only the direction of light (lenses, reflectors, all beam shaping optics) can never decrease the etendue for a given packet of flux.

Note 2 to entry: Etendue is expressed in m^{2}sr.

3.8
irradiance <at a point of a surface>
E_e
quotient of the radiant flux $d\Phi_e$ incident on an element of the surface containing the point, by the area dA of that element

Note 1 to entry: Irradiance (at a point of a surface) is expressed in W/m^2.

Note 2 to entry: The spectral power distribution of the irradiance, as a function of wavelength, is denoted by $E_\lambda(\lambda)$.

Note 3 to entry: For the purposes of this Technical Report, it is important to mention that when $E_\lambda(\lambda)$ is known, it can be converted to illuminance (E) when weighted with the CIE 1924 photopic eye sensitivity spectrum $V(\lambda)$, and to blue light weighted irradiance (E_B) when weighted with the blue light spectral weighting function as defined in IEC 62471.

[SOURCE: IEC 60050-845:1987, 845.01.37, modified — Notes 2 and 3 to entry are introduced.]

3.9
luminance <in a given direction, at a given point of a real or imaginary surface>
L
quantity defined by the formula

$$L = \frac{d\Phi}{dA \cdot \cos\theta \cdot d\Omega}$$

where $d\Phi$ is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle $d\Omega$ containing the given direction; dA is the area of a section of that beam containing the given point; θ is the angle between the normal to that section and the direction of the beam

Note 1 to entry: Luminance (in a given direction, at a given point of a real or imaginary surface) is expressed in cd/m^2.

[SOURCE: IEC 60050-845:1987, 845.01.35, modified — "L" instead of "L_V" is used. The note is deleted.]

3.10
blue light weighted radiance
L_B
radiance spectrally weighted with the blue light spectral weighting function as defined in IEC 62471

Note 1 to entry: Blue light weighted radiance is expressed in W/(m^2·sr).

3.11
light source
any product that produces light

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EXAMPLE LED package, LED module, lamp, luminaire

3.12
luminaire
apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply

[SOURCE: IEC 60050-845:1987, 845.10.01, modified — Notes 1 and 2 are deleted.]

3.13
luminaire optics
all luminaire components that modify the spatial and directional characteristics of the radiation emitted by the primary light source inside the luminaire

3.14
primary light source
surface or object emitting light produced by a transformation of energy

Note 1 to entry: For the purpose of this Technical Report, it may refer to an LED package, an LED module, or a lamp.

[SOURCE: IEC 60050-845:1987, 845.07.01, modified — A new note to entry is added.]

3.15
radiance <in a given direction, at a given point of a real or imaginary surface>
L_e
quantity defined by the formula

$$L_e = \frac{d\Phi_e}{dA \cdot \cos\theta \cdot d\Omega}$$

where $d\Phi_e$ is the radiant flux transmitted by an elementary beam passing through the given point and propagating in the solid angle $d\Omega$ containing the given direction; dA is the area of a section of that beam containing the given point; θ is the angle between the normal to that section and the direction of the beam.

Note 1 to entry: Radiance (in a given direction, at a given point of real or imaginary surface) is expressed in $W/(m^2 \cdot sr)$.

Note 2 to entry: The spectral power distribution of the radiance, as a function of wavelength, is denoted by $L_\lambda(\lambda)$.

Note 3 to entry: For the purposes of this document, it is important to mention, that when $L_\lambda(\lambda)$ is known, it can be converted to luminance (L) when weighted with the CIE 1924 photopic eye sensitivity spectrum $V(\lambda)$, and to blue light weighted radiance (L_B) when weighted with the blue light spectral weighting function as defined in IEC 62471.

[SOURCE: IEC 60050-845:1987, 845.01.34, modified — Notes to entry 1 to 5 are deleted and new notes to entry are introduced.]

3.16
risk group
RG
risk classification when the product, at the relevant evaluation position, gives rise to a certain t_{max} value, according to Table 1, as defined in IEC 62471

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Table 1 – Correlation between exposure time and risk group

Risk group number	Risk group name	Corresponding t_{max} range s
RG0	Exempt	> 10 000
RG1	Low risk	100 to10 000
RG2	Moderate risk	0,25 to100
RG3	High risk	< 0,25

3.17
maximum permissible exposure time
t_{max}
maximum permissible exposure time as calculated using the relevant formulae in 4.3.3 and 4.3.4 of IEC 62471:2006

3.18
true luminance
luminance value as obtained by integrating the equation as given in the definition of luminance, over a certain area of a light source, such that only the light emitting surface (or part of it) is included in the integration, and no dark surface area surrounding the light emitting part of the light source

Note 1 to entry: When a luminance measurement is performed over a certain field of view, it will only give a true luminance value when the field of view underfills the light emitting part of the light source.

3.19
true radiance
radiance value as obtained by integrating the equation as given in the definition of radiance , over a certain area of a light source, such that only the light emitting surface (or part of it) is included in the integration, and no dark surface area surrounding the light emitting part of the light source

Note 1 to entry: When a radiance measurement is performed over a certain field of view, it will only give a true radiance value when the field of view underfills the light emitting part of the light source.

3.20
LED package
one single electrical component encapsulating principally one or more LED dies, possibly with optical elements and thermal, mechanical, and electrical interfaces

Note 1 to entry: The component does not include the control unit of the controlgear, does not include a cap, and is not connected directly to the supply voltage.

Note 2 to entry: An LED package is a discrete component and part of the LED module. For a schematic build-up of an LED package, see Annex A of IEC 62504[1].

3.21
secondary optics
optics that are not part of the LED package itself

3.22
threshold distance
d_{thr}
distance from the light source at which the illuminance produced by that light source is equal to the E_{thr} value for that light source

[1] To be published.

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