SLOVENSKI STANDARD
SIST EN 4731:2018

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Aeronavtika - Spektralna kakovost LED-svetilk, ki se uporabljajo s fotoluminiscenčnimi sistemi označevanja

Aerospace series - Spectral quality of LED luminaires used with photoluminescent marking systems

Luft- und Raumfahrt - Spektrale Qualität von LED Leuchten zur Verwendung mit langnachleuchtenden Markierungssystemen

Série aérospatiale - Qualité spectrale des diodes électroluminescentes appliquées aux systèmes de marquage photoluminescents

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Aerospace series - Spectral quality of LED luminaires used with photoluminescent marking systems

Série aérospatiale - Qualité spectrale des luminaires à diodes électroluminescentes appliquées aux systèmes de marquage photoluminescents

Luft- und Raumfahrt - Spektrale Qualität von LED Leuchten zur Verwendung mit langnachleuchtenden Markierungssystemen

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 4731:2018) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2018, and conflicting national standards shall be withdrawn at the latest by November 2018.

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Introduction

Photoluminescent marking systems are commonly used in passenger airplanes to provide visual guidance in emergency events. Those marking systems need to be charged by ambient light during cabin preparation and/ or aircraft operation as to be operational if, at any phase of a flight, an emergency occurs.

While the certification regulations require photoluminescent marking system to be sufficiently charged solely by cabin interior lighting, i.e. without accounting for daylight entering the cabin through windows, only certain portions of the visual light spectrum emitted by a cabin interior luminaire are stored by the photoluminescent pigment and thus contribute to charging.

1 Scope

This document defines a measure for the spectral quality of LED luminaires in terms of the ratio of the amount of visual light emitted by the luminaire versus the amount effective for charging photoluminescent products contained in that spectrum.

Fulfilment of this document by a LED luminaire will ensure general compatibility of the luminaire with photoluminescent marking systems.

This document alone does not provide any means of compliance to fulfil any airworthiness requirements.

For a specific aircraft installation, the spectral power distribution and illuminance at the photoluminescent marking systems are relevant.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 4706, *Aerospace series — LED colour and brightness ranking*

CIE 018.2:1983, *The basis of physical photometry*

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

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
Light Emitting Diode
LED
solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current

3.2
single colour LED luminaire
luminaire using one or more LEDs as source of light whereas the luminaire is designed to operate in a single colour mode only

3.3
multiple colour LED luminaire
luminaire using two or more LEDs as source of light whereas the LEDs are of at least two different primary wavelengths and the luminaire is designed to operate in two or more colour modes by controlling the light output of the different primaries independently

3.4
spectral irradiance
$E\lambda(\lambda)$
function that relates the spectral irradiance $E\lambda$ of a light source to the wavelength λ

Note 1 to entry: The function's unit is [W/m^2/nm].

3.5
photopic luminosity function
$V(\lambda)$
function that relates the average spectral sensitivity of human visual perception of brightness at photopic light levels to the wavelength λ

Note 1 to entry: Published by the Commission Internationale de L'Éclairage (CIE) in steps of one nanometer with document CIE 018.2:1983.

3.6
photometrically weighted spectral irradiance
$EV\lambda(\lambda)$
function that is the product of spectral irradiance $E\lambda(\lambda)$ and photopic luminosity function $V(\lambda)$, and that relates the photometrically weighted spectral irradiance to the wavelength λ

Note 1 to entry: The function spectral irradiance's unit is [W/m^2/nm].

3.7
photometrically weighted irradiance
EV
integral of the photometrically weighted spectral irradiance $EV\lambda(\lambda)$ over the visual portion of the spectrum in the range of 360 nm to 780 nm

Note 1 to entry: $EV = \int_{\lambda=360nm}^{\lambda=780nm} EV\lambda(\lambda) \cdot d\lambda$

Note 2 to entry: The function's unit is [W/m^2].

Note 3 to entry: The photometrically weighted irradiance EV is proportional to the brightness perceived by the human eye or to the reading taken by a luxmeter. The range of 781 nm to 830 nm is neglected for simplicity.

3.8
approximated excitation spectrum for typical photoluminescent pigments based on strontium aluminate
$A\lambda(\lambda)$
linear function that represents an approximation of the spectral excitation sensitivity of common strontium aluminate (e.g. $SrAl_2O_4$) photoluminescent pigments related to the wavelength λ

Note 1 to entry: $A\lambda(\lambda) = -\frac{1}{130\ nm} \cdot \lambda + 3{,}7692$ valid for: λ is element of {360 nm to 490 nm}

Note 2 to entry: Annex A illustrates the approximated excitation spectrum $A\lambda(\lambda)$.

3.9
approximated weighted spectral excitation irradiance
$EA\lambda(\lambda)$
function that is the product of spectral irradiance $E\lambda(\lambda)$ and approximated excitation spectrum $A\lambda(\lambda)$, and that relates the approximated weighted spectral excitation irradiance to the wavelength λ

Note 1 to entry: The function's unit is [W/m^2/nm].

3.10
approximated weighted excitation irradiance
EA
integral of the approximated weighted spectral excitation irradiance $EA\lambda(\lambda)$ over the portion of the spectrum that contributes to charging

Note 1 to entry: $EA = \int_{\lambda=360nm}^{\lambda=490nm} EA\lambda(\lambda) \cdot d\lambda$

Note 2 to entry: The function's unit is [W/m^2].

3.11
excitation coefficient
Ce
quotient that results from dividing the approximated weighted excitation irradiance EA by the sum of approximated weighted excitation irradiance and the photometrically weighted irradiance EV

Note 1 to entry: $Ce = EA/(EA+EV)$ Ce is element of {0 to 1}

Note 2 to entry: The excitation coefficient indicates the spectral quality of a light source in view of charging strontium aluminate pigments relative to its brightness as perceived by the human eye or measured with a luxmeter. The bigger Ce is, the more effective is the light source with respect to charging of photoluminescent material.

4 Spectral quality

4.1 Method for determination of *Ce* for a luminaire

4.1.1 Single colour LED luminaires

The excitation coefficient Ce for single colour LED luminaires shall be determined according to the following steps:

1. Record the luminaire's spectral irradiance $E\lambda(\lambda)$ in steps of 1 nanometer (1 nm) in a steady state condition with a spectrometer in the wavelength range of 360 nm to 780 nm and an optical bandwidth not greater than 5 nm;

2. Calculate the photometrically weighted spectral irradiance $EV\lambda(\lambda)$ by multiplying the spectral irradiance $E\lambda(\lambda)$ and photopic luminosity function $V(\lambda)$ in steps of every nanometer;

3. Calculate the approximated weighted spectral excitation irradiance $EA\lambda(\lambda)$ by multiplying the spectral irradiance $E\lambda(\lambda)$ and the approximated excitation spectrum $A\lambda(\lambda)$ in steps of every nanometer;

4. Calculate the photometrically weighted irradiance EV within in the range of 360 nm to 780 nm;