SLOVENSKI STANDARD
SIST EN 14255-3:2008

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Merjenje in ocenjevanje izpostavljenosti oseb inkoherentnemu optiļ nemu sevanju - 3. del: Sonļ no UV-sevanje

Measurement and assessment of personal exposures to incoherent optical radiation - Part 3: UV-Radiation emitted by the sun

Messung und Beurteilung von personenbezogenen Expositionen gegenüber inkohärenter optischer Strahlung - Teil 3: Von der Sonne emittierte UV-Strahlung

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Mesure et évaluation des expositions individuelles au rayonnement optique incohérent - Parie 3: Rayonnement ultraviolet émis par le soleil

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ICS:

17.180.20	Barve in merjenje svetlobe	Colours and measurement of light
17.240	Merjenje sevanja	Radiation measurements

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EUROPEAN STANDARD

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Measurement and assessment of personal exposures to incoherent optical radiation - Part 3: UV-Radiation emitted by the sun

Mesurage et évaluation des expositions individuelles au rayonnement optique incohérent - Partie 3: Rayonnement ultraviolet émis par le soleil

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Contents

Page

iTeh STANDARD PREVIEW
(standards.iteh.ai)
SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0e-4a37-a2e6-13aa18b89888/sist-en-14255-3-2008

iTeh STANDARD PREVIEW
(standards.iteh.ai)
SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-13aa18b89888/sist-en-14255-3-2008

Foreword

This document (EN 14255-3:2008) has been prepared by Technical Committee CEN/TC 169 “Light and lighting”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by September 2008, and conflicting national standards shall be withdrawn at the latest by September 2008.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

EN 14255 *Measurement and assessment of personal exposures to incoherent optical radiation* is published in four parts:

— *Part 1: Ultraviolet radiation emitted by artificial sources in the workplace*

— *Part 2: Visible and infrared radiation emitted by artificial sources in the workplace*

— *Part 3 (this part): UV-Radiation emitted by the sun*

— *Part 4: Terminology and quantities used in UV-, visible and IR-exposure measurements*

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SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-13aa18b89888/sist-en-14255-3-2008

Introduction

People may be exposed to ultraviolet (UV) radiation emitted by artificial or natural sources. The most important natural source for UV-radiation exposure is the sun. Depending on global factors such as geographical position, season, time of day, altitude, cloudiness and individual factors such as clothing, the time spent outdoors may result in a significant UV-exposure to the sun.

Exposure to ultraviolet radiation from the sun is of considerable health concern. UV-exposure can produce both beneficial and harmful health effects. Vitamin D production is recognized as a beneficial effect. Acute harmful effects on the eyes and the skin can be induced by short term UV-irradiation of high intensity. Typical injuries are photoconjunctivitis and photokeratitis of the eye and UV-erythema of the skin. Minor doses of UV-radiation may induce or aggravate some diseases such as porphyria or lupus erythematosis or may trigger phototoxic and photoallergic reactions.

The visible and the infrared part of the radiation spectrum of the sun may also cause short term injuries, when overexposure occurs, such as thermal damage to the skin as well as thermal and photochemical injuries of the retina of the eyes. However, visible and infrared radiation exposures are not dealt with in this standard.

Additionally, long term UV-irradiation may result in damage to the eyes and skin, such as cataracts, skin aging and skin cancer. There is also increasing evidence that UV-exposure suppresses the immune system, which could lead to a reduction in the efficacy of immunization programmes and increase the spread of infectious diseases. Between two and three million non-melanoma skin cancers are diagnosed worldwide each year which are rarely fatal and can be surgically removed, approximately 132,000 melanoma skin cancers occur globally each year. Melanoma is responsible for approximately 80 % of an estimated 66,000 deaths annually due to skin cancer [1].

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SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-15aa18d89888/sist-en-14255-3-2008

Worldwide some 12 to 15 million people become blind from cataracts annually, of which up to 20% may be caused or aggravated by sun exposure, according to estimates by the World Health Organization (WHO). These numbers will increase as the stratospheric ozone layer is depleted over the next decades, unless people become aware of the hazards of UV-radiation exposure, especially from the sun [2].

In order to avoid short term injuries and reduce additional risks from long term UV-exposures international recommendations advise restriction of solar UV-exposures [3]. To achieve this, it is necessary to determine the level of solar UV-exposure and assess its gravity. Such determination can be achieved either by measurements or by estimations.

This European Standard supports the application of recommendations of international or European organisations (e. g. WHO, ICNIRP[1)] , EUROSKIN) for protection against harmful solar UV-exposure.

This standard specifies procedures for the measurement or estimation and the assessment of solar UV-exposures. For radiation protection purposes it is not always necessary to determine exactly the personal solar UV-exposure. Often a more general determination of the solar UV-exposure level is sufficient. The UV-Index is one of the means for that. The UV-Index can describe the current measured, the expected daily maximum, or the expected daily trend of the erythemally effective irradiance. It is based on regional measurements or calculations of the global solar radiation. It is published by various organisations and in weather forecasts. It can be used to forecast the expected solar UV-exposure and to plan protective measures, if necessary. So it is a means to determine an approximate personal solar UV-exposure. As the UV-Index is usually determined for a larger regional area the local solar UV-exposure may deviate due to different cloud cover and other reasons. So the local and individual UV-exposure assessment has to be adjusted accordingly.

1) ICNIRP International Commission on Non-Ionizing Radiation

A similar approach is the determination of the skin and ocular exposure factors [4, 5]. It allows an approximate local solar UV-exposure estimation. As it is not based on measurements the uncertainty may be larger than an estimation based on the UV-Index. However this method does take local factors (cloud cover, albedo) and individual factors (clothing and protective measures) into account.

For the planning of solar UV-radiation protection purposes when travelling, a calculation of the global solar radiation exposure depending on season, time of day, geographical position, etc. may be helpful. There are software programs which allow such calculations.

In some cases it is necessary to determine the personal solar UV-exposure more exactly. This can be done by measurements of the erythemal and/or the non-melanoma skin cancer radiant exposure. These exposure data can be used to determine individual risks.

Personal solar UV-exposures can in some cases also be determined by UV-exposure measurements according to EN 14255-1. The results can be compared to recommended or required limit values in order to assess the gravity of the exposure.

When the solar UV-exposure exceeds a certain level it may be necessary to apply protective measures in order to avoid injuries of the skin and the eyes. This standard does not specify sun protection measures but gives corresponding reference sources.

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SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-13aa18b89888/sist-en-14255-3-2008

1 Scope

This European Standard specifies procedures for the measurement or estimation and the assessment of personal exposures to ultraviolet radiation emitted by the sun.

NOTE 1 According to CIE 17.4 UV-radiation is defined as an electromagnetic radiation with wavelength between 100 nm and 400 nm. Due to atmospheric absorption only solar UV-radiation in the spectral region between 280 nm and 400 nm reaches the earth's surface in significant amounts.

This European Standard applies to solar UV-exposures when staying outdoors.

This European Standard is applicable to workers and to the general population.

This European Standard does not apply to UV-exposures caused by artificial sources, e.g. UV-lamps, welding arcs.

NOTE 2 Part 1 of this European Standard deals with UV-exposures caused by artificial sources.

NOTE 3 For radiation emissions of products other standards apply, such as CIE S 009 for lamps and lamp systems, EN 60335-2-27 [6] for sunbeds, EN 60335-2-59 [7] for insect killers and EN 12198 [8] for radiation emissions of machinery.

This European Standard does not apply to radiation exposures which concern the retina of the eyes.

NOTE 4 Ultraviolet and visible radiation exposures of the eyes may result in photochemical damage to the retina (this is often called the blue light hazard). The associated action spectrum contains mainly visible radiation and only a very small contribution in the ultraviolet region. The determination and assessment of radiation which may result in a blue light hazard may be done in accordance with part 2 of EN 14255 [20].

iTeh STANDARD PREVIEW
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SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-13aa18b89888/sist-en-14255-3-2008

2 Normative references

The following referenced documents are indispensable for the application 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 14255-1:2005, *Measurement and assessment of personal exposures to incoherent optical radiation — Part 1: Ultraviolet radiation emitted by artificial sources in the workplace*

EN 14255-4:2006, *Measurement and assessment of personal exposures to incoherent optical radiation — Part 4: Terminology and quantities used in UV-, visible and IR-exposure measurements*

CIE S 013, *International standard global solar UV-Index*

CIE 17.4, *International lighting vocabulary; Chapter 845: lighting*

CIE S 019, *Photocarcinogenesis Action Spectrum (Non-Melanoma Skin Cancers)*

ISO/CIE 17166, *Erythema reference action spectrum and standard erythema dose*

3 Terms and definitions

3.1 Symbols, terms and units

For the purposes of this document, the terms and definitions given in EN 14255-4:2006 and the following apply.

Table 1 — Symbols, terms and units

Symbol	Term	Unit	Defined in
λ	wavelength	nm	CIE 17.4 ref 845-01-14
λ_1 , λ_2	boundaries of a wavelength-range $\Delta\lambda$	nm	EN 14255-4
Δt_{exp}	exposure duration	s	EN 14255-4
E	irradiance	W/m²	CIE 17.4 ref 845-01-37
$E_\lambda(t,\lambda)$, $E_\lambda(\lambda)$	spectral irradiance	W/(m²·nm)	EN 14255-4
H	radiant exposure	J/m²	CIE 17.4 ref 845-01-42
$H_\lambda(\lambda)$	spectral radiant exposure	J/(m²·nm)	EN 14255-4
E_s	ultraviolet hazard irradiance	W/m²	EN 14255-4
H_s	ultraviolet hazard radiant exposure	J/m²	EN 14255-4
$s(\lambda)$	ultraviolet hazard weighting function	—	EN 14255-4
I_{UV}	solar UV-Index	—	CIE S 013
f_{SE}	skin exposure factor	—	3.2.2
$s_{er}(\lambda)$	erythemal weighting function	—	ISO/CIE 17166
E_{er}	erythemal effective irradiance	W/m²	ISO/CIE 17166
H_{er}	erythemal effective radiant exposure	J/m²	ISO/CIE 17166
SED	standard erythema dose	—	3.2.6
MED	minimal erythema dose	J/m² or SED	3.2.7
$s_{nmsc}(\lambda)$	non-melanoma skin cancer weighting function	—	CIE S 019
E_{nmsc}	non-melanoma skin cancer irradiance	W/m²	EN 14255-4
H_{nmsc}	non-melanoma skin cancer radiant exposure	J/m²	EN 14255-4

iTeh STANDARD PREVIEW
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SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-13aa18b89888/sist-en-14255-3-2008

3.2 Definitions

3.2.1
solar UV-Index
***I*UV**
quantity which expresses the erythemal potential of the terrestrial solar UV-radiation, incident on a horizontal plane, given by

$$I_{UV} = k_{er} \cdot \int_{250nm}^{400nm} E_\lambda(\lambda) \cdot s_{er}(\lambda)\, d\lambda \quad (1)$$

where

$E_\lambda(\lambda)$ is the solar spectral irradiance

$s_{er}(\lambda)$ is the erythemal weighting function as specified by ISO/CIE 17166

k_{er} is a constant equal to 40 m^2/W.

NOTE 1 The UV-Index is quoted to the nearest whole integer value. The irradiance measurement is carried out on an unobstructed horizontal plane e.g. on top of a building.

NOTE 2 This is a simplified definition. More information about the international standard global UV-Index can be found in CIE S 013 which is based on the recommendations of WHO/WMO/UNEP/ICNIRP [3].

NOTE 3 The solar UV-Index was developed as a simple scale for the public domain and for public information about the risk of erythema and related hazards from solar exposures. It is used e.g. in weather forecasts.

3.2.2
Skin exposure factor
f

$\boldsymbol{f_{SE}}$

quantity that estimates the severity of solar UV skin exposure accounting for environmental and individual variables, given by

$f_{SE} = f_1 \cdot f_2 \cdot f_3 \cdot f_4 \cdot f_5 \cdot f_6$ (see [4], [5]) (2)

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where

f_1 is the factor depending on geographical latitude and season;

SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-
0da09ef19888/sist-en-14255-3-2008

f_2 is the factor depending on cloud cover;

f_3 is the factor depending on duration of exposure;

f_4 is the factor depending on ground reflectance;

f_5 is the factor depending on clothing;

f_6 is the factor depending on shade.

3.2.3
erythemal effective radiant exposure

$\boldsymbol{H_{er}}$

radiant exposure spectrally weighted with the erythemal weighting function $s_{er}(\lambda)$, given by:

$$H_{er} = \int_{\Delta t_{exp}} \int_{250nm}^{400nm} E_\lambda(\lambda) \cdot s_{er}(\lambda) d\lambda dt \quad (3)$$

or:

$$H_{er} = \int_{\Delta t_{exp}} E_{er}(t) dt \quad (4)$$

where

$E_\lambda(\lambda)$ is the spectral irradiance;

E_{er} is the erythemal effective irradiance;

$s_{er}(\lambda)$ is the erythemal weighting function;

Δt_{exp} is the exposure duration.

NOTE The erythemal effective radiant exposure is defined, from 250 nm to 400 nm, in ISO/CIE 17166

3.2.4
erythemal weighting function
$s_{er}(\lambda)$
spectral weighting function reflecting the erythemal effect of ultraviolet radiation on the skin.

NOTE 1 The definition is derived from ISO/CIE 17166. CIE uses a slightly different name: *"*erythema action spectrum*"*. Values for this function are specified in ISO/CIE 17166 within a wavelength range from 250 nm to 400 nm.

3.2.5
standard erythema dose
SED
standardised measure of the erythemal effective radiant exposure H_{er}

NOTE 1 1 SED is equivalent to an erythemal effective radiant exposure of 100 J/m². SED is used as a unit in order to express the minimal erythema dose of an individual person, e. g.: 1 *MED* = 2,5 SED.

NOTE 2 The definition of the standard erythema dose is derived from ISO/CIE 17166.

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3.2.6
minimal erythema dose
MED
measure of the erythemal effective radiant exposure that produces a just noticeable erythema on the skin of an individual person

SIST EN 14255-3:2008
https://standards.iteh.ai/catalog/standards/sist/e48b46d7-7b0a-4a37-a2e6-13aa18b89888/sist-en-14255-3-2008

NOTE The *MED* is a subjective measure based on the reddening of the skin; it depends on many variables, e. g. individual sensitivity to UVR, radiometric characteristics of the source, skin pigmentation, anatomic site, elapsed time between irradiation and observing the reddening (typical value: 24 h), etc. (taken from ISO/CIE 17166). It should be reserved solely for observational studies in humans and animals. The *MED* is either expressed in J/m² or in SED.

3.2.7
non-melanoma skin cancer weighting function
$s_{nmsc}(\lambda)$
spectral weighting function reflecting the spectral dependency of the risk of causation of non-melanoma skin cancer by UV-exposure.

NOTE Values for this function are specified in CIE S 019 within a wavelength range from 250 nm to 400 nm.

3.2.8
non-melanoma skin cancer irradiance
E_{nmsc}
irradiance spectrally weighted with the non-melanoma skin cancer weighting function $s_{nmsc}(\lambda)$, given by:

$$E_{nmsc} = \int_{250\,nm}^{400\,nm} E_\lambda(\lambda) \cdot s_{nmsc}(\lambda) \mathrm{d}\lambda \qquad (5)$$

where

$E_\lambda(\lambda)$ is the spectral irradiance;