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Light and lighting — Maintenance factor determination — Way of working

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

ISO collaborates closely with the International Commission on Illumination (CIE) on all matters of standardization for light and lighting.

This document was prepared by Technical Committee ISO/TC *274*, *Light and lighting*. The document has been jointly prepared with CIE JTC 11, *Light and Lighting — Maintenance factor — Way of working*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Continuous maintenance of lighting installations is essential as it ensures that the performance of a system stays within the design limits and promotes safety and efficient use of energy. In the design phase this is taken into account through the use of the maintenance factor. The maintenance factor combines several different factors such as the assumed product/installation behaviour, the environmental parameters and maintenance and cleaning schedules.

The methodology of determining the maintenance factor has been extensively documented by CIE (see Clause 2 and bibliography). However, as the focus of these technical reports was predominantly on incandescent and gas discharge light sources, more clarity is needed to ensure the proper use/translation of the existing methodology towards technologies such as light emitting diodes (LED).

Technologies such as LED distinguish themselves from other technologies by their long lifetime, low failure rate and their integration of components which were previously seen as separate components. As such the previous methods used to determine the depreciation and survival of luminaires might seem unusable and cause uncertainty. However, based on work by IEC (see Clause 2) the luminous flux depreciation and light source failure parameters have now been (re)established for LED-based light sources and allow for translation into an updated way of working to determine the maintenance factor using the existing CIE methodology and data for luminaire and surface dirt depreciation.

This document combines insights from IEC standards with regard to product performance of luminaires and light sources currently in the market with the existing determination methodology from CIE Technical Reports. Furthermore, it references the data in the CIE Technical Reports with regard to the impact of the environment on luminaires (accumulation of dirt on surfaces and luminaires).

This document provides the following:

— background information with respect to the principles of the maintenance factor and the relevant parameters for indoor and outdoor applications;

— a detailed way of working on how to apply the maintenance factor determination method (as described in CIE 154:2003 and CIE 097:2005) for outdoor and indoor lighting designs using the technologies available in the market;

— explanation and examples on how to apply the maintenance factor and how to ensure proper operation over time corresponding to the determined values.

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Light and lighting — Maintenance factor determination — Way of working

1 Scope

This document specifies a standardized way of working for determining the maintenance factor for both outdoor and indoor lighting installations using the methodology as described in CIE 154:2003 and CIE 097:2005.

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.

CIE 097:2005, *Maintenance of Indoor Electric Lighting Systems*

CIE 154:2003, *Maintenance of Outdoor Lighting Systems*

CIE S 017, *ILV International Lighting Vocabulary*

IEC 62722-2-1, *Luminaire performance — Part 2-1: Particular requirements for LED luminaires*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CIE S 017 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
abrupt failure value
AFV
percentage of LED based products failing to operate at median useful life (L_x)

[SOURCE: IEC 62717:2014+AMD1:2015, modified — generalized to products]

3.2
cleaning interval
planned time between cleaning of (parts of) the products and/or components

3.3
CLO lifetime
time over which the *CLO* (3.5) feature ensures a constant luminous flux

3.4
component replacement interval
planned time between replacement of one or more specified luminaire component(s)

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3.5
CLO
constant light output
functionality to constantly adjust the luminous flux of the light source based on the known or predicted depreciation behaviour of the light source to enable a constant luminous flux over time

3.6
failure probability
$p_{\mathbf{f}}$
probability that the component (e.g. light source, luminaire) catastrophically fails

Note 1 to entry: Failure probability is expressed as a factor.

3.7
installation lifetime
time over which the installation is expected to function as designed

3.8
maintenance period
total time over which the maintenance is planned

Note 1 to entry: Within a single maintenance period different maintenance cycles can be planned for different activities (e.g. cleaning, light source replacement).

Note 2 to entry: The maintenance period is often expressed in years.

3.9
median useful life
$L_{\mathbf{x}}$
length of time until 50 % of a population of operating LED products reaches gradual light output degradation of a percentage x

3.10
surface refurbishment interval
planned time between surface refurbishment instances where the reflecting properties of the room or area surfaces are restored to their original state, including cleaning or painting of interior surfaces such as walls and ceilings

Note 1 to entry: The concept 'surface refurbishment interval' does not refer to surfaces which are an integral part of the luminaire.

3.11
survival probability
$p_{\mathbf{s}}$
probability that a component continues to operate at a certain point in time

Note 1 to entry: Survival probability is expressed as a factor.

Note 2 to entry: The component can be e.g. a light source, a luminaire.

Note 3 to entry: There is a distinct difference between the survival factor (see 6.3) and the survival probability. The survival probability describes the performance of an individual component whereas the survival factor describes the outcome of the determination process as described in 6.3.

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3.12
useful life
$L_{x,By}$[1)]
<of LED luminaires> length of time until a percentage y of a population of operating LED luminaires reaches gradual light output degradation of a percentage x, expressed in general in the '$L_{x,By}$' format

Note 1 to entry: Useful life can be specified on different product levels such as on individual LED, LED module or LED luminaire level. As for example luminaire design impacts thermal design, the useful life of the LED module might be different from the useful life of the luminaire.

[SOURCE: IEC 62717:2014+AMD1:2015, modified — specifier <of LED luminaires> and quantity symbol added to the term]

4 Symbols and units

The symbols and units in Table 1 apply.

Table 1 — Symbols and units

Symbol	Term	Unit
E_A	measured illuminance	lx
$E_{A,c}$	corrected measured illuminance	lx
E_m	maintained illuminance	lx
E_{in}	initial illuminance	lx
f_{LF}	luminous flux factor (see 6.2)	1
f_{LLM}	lamp luminous flux maintenance factor	1
f_{LM}	luminaire maintenance factor (see 6.4)	1
f_m	maintenance factor (see 6.1) NOTE In this document the term "maintenance factor" is used for luminaires either with integrated or separate light sources, in contrast to CIE 97 and CIE 154 where the light source is generally seen as separate from the luminaire.	1
f_S	survival factor (see 6.3)	1
f_{SM}	surface maintenance factor (see 6.5)	1
Φ_L	luminaire luminous flux	lm
Φ_{CLO}	CLO-corrected luminaire luminous flux	lm
Φ_S	standard luminaire luminous flux	lm
Φ_e	end-of-life luminaire luminous flux	lm
Φ_i	initial luminaire luminous flux	lm
L_x	median useful life (see 3.8) for x % remaining luminous flux	h
$L_{x,By}$	useful life	h
p_f	failure probability	1
p_s	survival probability	1

1) Note that in the source IEC 62717 the expression "L_xB_y" is incorrectly presented as a quantity symbol for the term "useful life". As such, this document introduces the symbol $L_{x,By}$ for the term "useful life" for use in this document and further usage.

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