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Light and lighting – Energy performance of lighting in buildings — Calculation of the impact of daylight utilization

Contents

Foreword

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This document was prepared by Technical Committee ISO/TC 274, *Light and lighting,* in collaboration with the International Commission on Illumination (CIE), JTC 06, *Energy Performance of Lighting in Buildings*.

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~~www.iso.org/members.html.

Introduction

This document is part of a set of standards which allows users to rate the overall energetic performance of buildings. Facades and rooflights have a key impact on the building's energy balance. This document supports daylighting and lighting-energy-related analysis and optimization of facade and rooflight systems. It is specifically devised to establish conventions and procedures for the estimation of daylight penetrating buildings through vertical facades and rooflights, as well as on the energy consumption for electric lighting as a function of daylight provided in indoor spaces.

Light and lighting – Energy performance of lighting in buildings — Calculation of the impact of daylight utilization

1 Scope

This document defines the calculation methodology for determining the monthly and annual amount of usable daylight penetrating non-residential buildings through vertical facades and rooflights and the impact thereof on the energy demand for electric lighting. This document is applicable for existing buildings and the design of new and renovated buildings.

This document provides the overall lighting energy balance equation relating the installed power density of the electric lighting system with daylight supply and lighting controls (proof calculation method).

The determination of the installed power density is not in the scope of this method, neither are controls relating, for instance, to occupancy detection. Provided the determination of the installed power density and control parameters using external sources, the internal loads by lighting and the lighting energy demand itself can be calculated. The energy demand for lighting and internal loads by lighting can then be taken into account in the overall building energy balance calculations:

— heating;

— ventilation;

— climate regulation and control (including cooling and humidification);

— heating the domestic hot-water supply of buildings.

For estimating the daylight supply and rating daylight-dependent electric lighting control systems, a simple table-based calculation approach is provided. The simple method describes the division of a building into zones as required for daylight illumination-engineering purposes, as well as considerations on the way in which daylight supplied by vertical facade systems and rooflights is utilized and how daylight-dependent lighting control systems affect energy demand. Dynamic vertical facades with optional shading and light redirection properties are considered, i.e. allowing a separate optimization of facade solutions under direct insolation and under diffuse skies. For rooflighting systems, standard, static solutions like shed rooflights and continuous rooflights are considered. The method is applicable for different latitudes and climates. For standard building zones (utilizations), operation times are provided.

For detailed analysis an approach to calculate the effect of daylight on the lighting energy demand on an hourly or sub-hourly basis is provided. Unlike the simple table-based annual calculation approach, which is regression based, this method relies on an emulation concept. –Relevant quantities are modelled explicitly and are then interacting directly with sensors, actuators and functional elements of the BACS or are triggering user interaction. By this approach, model configuration and parametrization from the design stage can seamlessly be used in the BACS configuration.

To support overall building performance assessment, additional daylight performance indicators on the overall building level are provided.

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 S 017:2020, *ILV: International Lighting Vocabulary*

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 terminology databases for use in standardization at the following addresses:

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

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

CIE maintains a terminology database for use in standardization at the following address:

— e-ILV: available at https://cie.co.at/e-ilvhttps://cie.co.at/e-ilv

3.1
control system
various types of electrical and electronic systems including the following:

— systems used to control and regulate;

— systems to protect against solar radiation and/or glare;

— electric lighting in relation to the currently available daylight;

— systems used to detect and record the presence of occupants

3.2
daylight factor
D
quotient of the illuminance at a point on a given plane due to the light received directly and indirectly from a sky of assumed or known luminance distribution and the illuminance on a horizontal plane due to an unobstructed hemisphere of this sky, where the contribution of direct sunlight to both illuminances is excluded

Note 1 to entry: Glazing, dirt effects, etc. are included.

Note 2 to entry: When calculating the lighting of interiors, the contribution of direct sunlight has to be considered separately.

Note 3 to entry: CIE S 017:2020 defines the unit as 1. However, daylight factor is in practice, usually presented in percent values.

Note 4 to entry: The term daylight factor is normally used when considering an overcast sky as sky type 1 or 16 in ISO 15469.

[SOURCE: CIE S 017:2020, 17-29-121, modified, — Notes 3 to 5 deleted, new notesNotes to entry 3 and 4 added]

3.3
electrical power of electric lighting system
P
total electrical power consumption of the lighting system in the considered space

3.4
illuminance
E

density of incident luminous flux with respect to area at a point on a real or imaginary surface

$$E = \frac{d\Phi_v}{dA},$$

where Φ_v is luminous flux and A is the area on which the luminous flux is incident

$$E = \frac{d\Phi_v}{dA},$$

where

- Φ_v is luminous flux;
- A is the area on which the luminous flux is incident

Note 1 to entry: The illuminance is expressed in lux (lx = lm · m^{-2}).

[SOURCE: CIE S 017:2020, 17-21-060, modified: — Notes 1, 2, 4 and 5 deleted]

3.5
insolation
incidence of solar radiation on a surface or body

3.6
luminaire
apparatus which distributes, filters or transforms the light transmitted from at least one source of optical radiation and which includes, except the sources themselves, all the parts necessary for fixing and protecting the sources and, where necessary, circuit auxiliaries together with the means for connecting them to the power supply

[SOURCE: CIE S 017:2020, 17-30-001, modified: — Notes deleted]

3.7
luminous exposure
H_v
H
density of incident luminous energy with respect to area at a point on a real or imaginary surface

~~$H_v = \frac{dQ_v}{dA}$~~

~~where Q_v is luminous energy and A is the area on which the luminous energy is incident~~

$$H_v = \frac{dQ_v}{dA}$$

where

- Q_v is the luminous energy;
- A is the area on which the luminous energy is incident.

Note 1 to entry: The luminous exposure is expressed in lux second (lx·s = lm·s·m^{-2}).

[SOURCE: CIE S 017:2020, 17-21-072, modified: — Notes 1, 2, 3, 5 and 6 deleted]

3.8
luminous flux
Φ
Φ_v
change in luminous energy with time

~~$\Phi_v = \frac{dQ_v}{dt}$~~

~~where Q_v is the luminous energy emitted, transferred or received, and t is time~~

$$\Phi_v = \frac{dQ_v}{dt}$$

where

- Q_v is the luminous energy emitted;
- t is time.

Note 1 to entry: The luminous flux is expressed in lumen (lm).

[SOURCE: CIE S 017:2020, 17-21-039, modified: — Notes 1, 2, 3, 5 and 6 deleted]

3.9
maintained average illuminance
~~$\bar{E}_m$~~
$\bar{E}_m$
value below which the average illuminance over the specified surface is not allowed to fall

Note ~~2~~1 to entry: In specific contexts of this document the maintained average illuminance can in limit case be the maintained point illuminance

Note ~~1~~ 2 to entry: Unit: lx = lm · m^{-2}.