



DRAFT INTERNATIONAL STANDARD ISO/DIS 10916

ISO/TC 163/SC 2

Secretariat: **SN**

Voting begins on
2013-07-03

Voting terminates on
2013-10-03

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Calculation of the impact of daylight utilization on the net and final energy demand for lighting

Calcul de l'effet d'utiliser la lumière du jour à la demande énergétique net et finale pour l'éclairage

ICS 91.160.01

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
<https://standards.iteh.ai/catalog/standards/sist/9c1446f4-d7e7-4108-ac01-853ef4811e5f/iso-10916-2014>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2013

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

| | |
|--|-----|
| Foreword | vi |
| Introduction..... | vii |
| 1 Scope | 1 |
| 2 Normative references | 2 |
| 3 Terms and definitions | 2 |
| 4 Symbols, indices and abbreviated terms..... | 4 |
| 4.1 Symbols..... | 4 |
| 4.2 Indices | 5 |
| 5 Proof calculation method | 5 |
| 5.1 Energy demand for lighting as function of daylight | 5 |
| 5.2 Subdivision of a building into zones | 7 |
| 5.3 Operating time | 8 |
| 5.4 Artificial lighting | 8 |
| 5.5 Constant illuminance control | 8 |
| 5.6 Daylight..... | 8 |
| 5.7 Occupancy dependency factor $F_{O,n}$ | 9 |
| 6 Daylight Performance Indicator | 9 |
| Annex A (informative) Simple calculation method | 10 |
| A.1 General | 10 |
| A.2 Building segmentation: Spaces benefiting from daylight..... | 12 |
| A.3 Daylight supply factor for vertical façades..... | 14 |
| A.3.1 Daylight factor classification | 14 |
| A.3.2 Daylight supply factor..... | 19 |
| A.4 Daylight supply factor for rooflights | 34 |
| A.4.1 Daylight availability factor | 34 |
| A.4.2 Daylight supply factor..... | 37 |
| A.5 Daylight Responsive Control Systems | 43 |
| A.6 Monthly evaluation method | 44 |
| A.7 Determination of daytime and night-time hours | 45 |
| A.8 Exemplary operation times of different building zone | 48 |
| Annex B (normative) Comprehensive calculation..... | 50 |
| Annex C (informative) Daylight performance indicator | 51 |
| Annex D (informative) Examples | 52 |
| D.1 Space with vertical façade..... | 52 |
| D.2 Space with rooflights | 55 |
| D.2.1 General | 55 |
| D.2.2 Determination of the daylight availability factor $F_{D,S}$ | 56 |
| D.2.3 Determination of the annual and monthly final energy demand for lighting | 58 |
| Bibliography..... | 61 |

Tables

| | |
|--|----|
| Table A.1 — Daylight availability classification as a function of the daylight factor $D_{Ca,j}$ of the raw building carcass opening..... | 19 |
| Table A.2 — Representative locations on the northern and southern hemisphere with the corresponding radiation ratios H_{dir}/H_{glob} | 22 |
| Table A.3 — Relative times $t_{rel,D,SNA,j}$ for not activated solar radiation and/or glare protection systems, as a function of the façade orientation, the geographic latitude γ and the ratio H_{dir}/H_{global} | 23 |
| Table A.4 — Typical values of the transmittance $\tau_{D65,SNA}$ of transparent and translucent building components..... | 25 |
| Table A.5 — Daylight supply factor $F_{D,s,SNA,j}$ for sun shading not activated parameterized by D , γ , \bar{E}_m , climate (H_{dir}/H_{glob}), façade orientation, and geographic location for orientation South..... | 27 |
| Table A.6 — Daylight supply factor $F_{D,s,SNA,j}$ for sun shading not activated parameterized by D , γ , \bar{E}_m , climate (H_{dir}/H_{glob}), façade orientation, and geographic location for orientations East/ West..... | 29 |
| Table A.7 — Daylight supply factor $F_{D,s,SNA,j}$ for sun shading not activated, parameterized by D , γ , \bar{E}_m , climate (H_{dir}/H_{glob}), façade orientation, and geographic location for orientation North..... | 31 |
| Table A.8 — System solutions (values to be applied for the period $t_{rel,D,SA,j}$)..... | 33 |
| Table A.9 — Typical values of the transmittance τ_{D65} , U and g of components frequently used in rooflight construction..... | 35 |
| Table A.10 — External daylight factor D_a as a function of the façade slope γ_F for a floor reflectance ρ_B of 0,2 (without building shading)..... | 38 |
| Table A.11 — Dome skylight utilances η_R , expressed as a percentage, as a function of the space index k and the geometry parameters of the annular support design..... | 39 |
| Table A.12 — Shed rooflight utilances η_R , expressed as a percentage, as a function of the space index k and the geometry parameters..... | 36 |
| Table A.13 — Classification of daylight availability as a function of the daylight factor \bar{D}_j | 37 |
| Table A.14 — Daylight availability factor $F_{D,s,j}$ of spaces with skylights as a function of the daylight availability classification, the maintained illuminance \bar{E}_m , façade orientation and incline, location γ and climate (H_{dir}/H_{glob})..... | 38 |
| Table A.15 — Correction factor $F_{D,c,j}$ to account for the impact of daylight responsive control systems in a zone n , as a function of the maintained illuminance \bar{E}_m and the daylight availability classification..... | 44 |
| Table A.16 — Monthly distribution key factors $v_{Month,i}$ for vertical façades..... | 44 |
| Table A.17 — Monthly distribution key factors $v_{Month,i}$ for rooflights..... | 45 |

| | |
|--|----|
| Table A.18 — t_{day} and t_{night} as a function of latitude for typical operating hours from 8 am – 5 pm, weekends excluded | 47 |
| Table A.19 — Data for usage of boundary conditions for non-residential buildings | 48 |
| Table D.1 — Boundary conditions for the example with vertical façade | 53 |
| Table D.2 — $F_{D,s,SNA,j}$, $F_{D,s,SA,j}$, $F_{D,s,j}$ and $Q_{L,f}$ for system solutions 1, 2, 3 at the locations under investigation | 55 |
| Table D.3 — Monthly final energy demand for strip type rooflights | 60 |
| Table D.4 — Monthly final energy demand for shed rooflights | 60 |

Figures

| | |
|---|----|
| Figure 1 — Flowchart showing calculation of the energy demand for lighting | 7 |
| Figure A.1 — Flowchart illustrating the simplified approach | 11 |
| Figure A.2 — Three stage approach to determining the daylight supply factor $F_{D,s,j}$ | 12 |
| Figure A.3 — Impact of façade opening on daylight area for vertical façades | 14 |
| Figure A.4 — Impact of roof opening on daylight area for rooflights | 14 |
| Figure A.5 — Cross section diagram to illustrate the effect of the linear shading altitude angle $\gamma_{V,IV}$ | 16 |
| Figure A.6 — Cross section diagram to illustrate the effect of the horizontal shading angle $\gamma_{V,hA}$ | 16 |
| Figure A.7 — Cross section diagram to illustrate the effect of the vertical shading angle $\gamma_{Sh,vf}$ | 17 |
| Figure A.8 — Illustration of the geometrical parameters used to define the well index w_i | 18 |
| Figure A.9 — Selected sites for which radiation ratios H_{dir}/H_{glob} are provided with assignment of latitude corridors and direct normal radiation | 21 |
| Figure A.10 — Example of a set of functions used to determine the daylight supply factor $F_{D,s,SNA,j}$ and $F_{D,s,SA,j}$ as a function of D and γ according to Table (A.5) for $\bar{E}_m = 500$ lx and a south facing façade | 26 |
| Figure A.11 — Dimensions used to describe the geometry of the annular supports of spaces with dome and strip skylights | 39 |
| Figure A.12 — Dimensions used to describe the geometry of shed rooflights | 39 |
| Figure D.1 — Geometry of the example with vertical façade | 52 |
| Figure D.2 — Rooflights | 56 |

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 10916 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
<https://standards.iteh.ai/catalog/standards/sist/9c1d46f4-d7e7-4108-ac01-853ef4811e5f/iso-10916-2014>

Introduction

This ISO Standard is part of a set of standards allowing to rate the overall energetic performance of buildings. Facades and rooflights have a key impact on the buildings energy balance. This ISO Standard supports the daylighting and lighting energy related analysis and optimization of façade and rooflight systems. It was therefore 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.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
<https://standards.iteh.ai/catalog/standards/sist/9c1446f4-d7e7-4108-ac01-853ef4811e5f/iso-10916-2014>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Full standard:
<https://standards.iteh.ai/catalog/standards/sist/9c1446f4-d7e7-4108-ac01-853ef4811e5f/iso-10916-2014>

Calculation of the impact of daylight utilization on the net and final energy demand for lighting

1 Scope

This ISO standard 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. The standard can be used for existing buildings and the design of new and renovated buildings.

The standard 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) and
- heating the domestic hot-water supply

of buildings.

For estimating the daylight supply and rating daylight dependent artificial 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 façade systems and rooflights is utilized and how daylight dependent lighting control systems effect energy demand. Dynamic vertical facades with optional shading and light redirection properties are considered, i.e. allowing a separate optimization of façade 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 computer based analysis (comprehensive calculation) minimum requirements are specified.

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

2 Normative references

No normative references apply.

3 Terms and definitions

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

3.1

ballast

unit inserted between the supply and one or more discharge lamps which by means of inductance, capacitance, or a combination of inductance and capacitance, serves mainly to limit the current of the lamp(s) to the required value

3.2

control system

various types of electrical and electronic systems:

- used to control and regulate;
- systems to protect against solar radiation and/or glare;
- artificial lighting in relation to the currently available daylight;
- used to detect and record the presence of occupants.

3.3

daylight factor [*D*]

ratio 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, to 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

Unit: 1

3.4

electrical power of artificial lighting system [*P*]

the total electrical power consumption of the lighting system in the considered space

3.5

illuminance [*E*]

quotient of the luminous flux incident on an element of the surface containing the point, by the area of that element

Unit: $\text{lx} = \text{lm} \times \text{m}^{-2}$

3.6

lamp

source made in order to produce optical radiation, usually visible

3.7

light reflectance

ratio of the reflected luminous flux to the incident luminous flux in the given conditions

Unit: 1

3.8**light transmittance**

ratio of the transmitted luminous flux to the incident luminous flux in the given conditions

Unit: 1

3.9**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

3.10**luminous exposure**

quotient of quantity of light dQ_v incident on an element of the surface containing the point over the given duration, by the area dA of that element

Unit: $\text{lx} \times \text{s} = \text{lm} \times \text{s} \times \text{m}^{-2}$

3.11**luminous flux $[\Phi]$**

quantity derived from the radiant flux, Φ_e , by evaluating the radiation according to its action upon the CIE standard photometric observer

Unit: lm

3.12**maintained illuminance $[\bar{E}_m]$**

value below which the average illuminance over the specified surface is not allowed to fall

Unit: $\text{lx} = \text{lm} \times \text{m}^{-2}$

3.13**obstruction**

anything outside the window which prevents the direct view of part of the sky

3.14**Rooflight**

daylight opening on the roof or on a horizontal surface of a building

3.15**task area**

partial area in the work plane in which the visual task is carried out

3.16**visual task**

visual elements of the work being done

4 Symbols, indices and abbreviated terms

For the purposes of this document, the following symbols and units apply.

4.1 Symbols

| Symbol | Quantity | Unit |
|-------------|---|------------------|
| τ | light transmittance | — |
| ρ | Light reflectance | — |
| φ | luminous flux | lm |
| η | efficiency | — |
| a | depth | m |
| A | area | m ² |
| b | width | m |
| bf | occupancy factor | — |
| C | correction factor | — |
| D | daylight factor | % |
| \bar{E}_m | maintained illuminance | lx |
| f, F | factors | — |
| h | height | m |
| k | space index | — |
| k | correction factor | — |
| J | counter for number of areas being evaluated | — |
| N | counter for number of zones | — |
| p | area-specific power | W/m ² |
| t | time | h |
| v | distribution key | — |
| w_i | light-well index | — |

4.2 Indices

| | | | |
|---------|---|-------|---|
| ext | external, outdoors | ND | no daylight |
| A | absence | Night | night-time |
| At | atrium, atrium | O | occupancy |
| c | control | rel | relative |
| Ca | Carcass opening | Rd | room depth, space depth |
| D | daylight | s | transparent or translucent surface of the daylight aperture |
| D65 | standard lightsource D65 | s | supply |
| Day | day-time | SA | sun-shading activated |
| eff | effective, root-mean-square | Sh | shading, obstruction |
| ext | external, outdoors | SNA | sun-shading not activated |
| GDF | glazed curtain wall, glazed double façade | t | building use (operating) time |
| hf | horizontal fin or projection | Ta | task area |
| i,j,n | serial counter indices | Tr | transparency |
| Li | lintel | u | lower |
| In | internal courtyard | vf | vertical fin or projection |
| Ish | linear shading | | |

5 Proof calculation method

5.1 Energy demand for lighting as function of daylight

The final energy demand for lighting purposes is $Q_{l,f}$ to be determined for a total of N building zones which can be subdivided into J evaluation areas:

$$Q_{l,f} = \sum_{n=1}^N \sum_{j=1}^J Q_{l,b,n,j} \quad (1)$$

The energy demand of any one evaluation area j is calculated by applying the following Formulae:

$$Q_{l,n,j} = p_j F_{c,j} \left[A_{D,j} (t_{\text{eff,Day,D},j} + t_{\text{eff,Night},j}) + A_{ND,j} (t_{\text{eff,Day,ND},j} + t_{\text{eff,Night},j}) \right] \quad (2)$$

where

$$A_j = A_{D,j} + A_{ND,j} \quad (3)$$

applies to the total area of the respective evaluation area,