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Building environment design — Indoor environment — Design process for visual environment

Conception de l'environnement des bâtiments — Environnement intérieur — Processus de conception de l'environnement visuel

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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.

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 16817 was prepared by Technical Committee ISO/TC 205, *Building environment design*.

Introduction

ISO/TC 205 provides general principles for the design of building indoor environment. These principles are defined in ISO 16813 and help the main participants in the design process to ensure an indoor environment of the quality required for users.

The purpose of this International Standard is to provide design team members with a design process for the indoor visual environment to ensure required visual comfort, physiological effects of light and energy performance and sustainability of buildings. Visual comfort implies more than providing a comfortable lighting environment for executing a task. For example, a window has two functions: to facilitate the entry of daylight and to provide a view.

The design of an indoor visual environment of the required quality for users must take into account human needs that include elements linked to task performance, visual comfort, health, safety and well-being in reference with the work of ISO/TC 159 *Ergonomics*. With respect to illuminating engineering and lighting fixtures, the work requires close consultation with CIE (International Commission on Illumination). The existing standards of CIE and CEN will be used and any new work will be performed in close coordination with CIE and CEN.

This International Standard:

— provides a framework for taking into consideration various parameters and criteria that influence the quality of the indoor visual environment;

— is prepared for design teams (architects and engineers), as well as building clients, contractors, government officials, and academic staff;

— is aimed at assisting these groups in applying an effective design process in the pursuit of an indoor visual environment of the required quality for the users;

— incorporates sustainability considerations;

— is prepared on the basis of the following fundamental ideas:

i) it addresses the standardization of a design process elaborated through a systemic approach, a system of tasks that are structured together;

ii) it is a guideline which invites designers to follow an iterative and progressive approach, to make choices and take compromise solutions according to the goals of the client, to the constraints and the opportunities linked to the building site, in relation to the main areas of work covered by ISO/TC 205;

iii) it allows the performance level or values to be established by the programme and/or applicable regulation.

Building environment design — Indoor environment — Design process for visual environment

1 Scope

This International Standard provides an integrated design process for high-quality indoor visual environment including architectural and engineering aspects of daylighting and artificial lighting for user satisfaction, well-being and productivity as well as the energy performance and sustainability of buildings.

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.

ISO 15686-5:2008, *Buildings and constructed assets — Service-life planning — Part 5: Life-cycle costing*

IEC 60050-845/CIE 017.4:1987, *International Electrotechnical Vocabulary. Lighting*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-845/CIE 017.4 and the following apply.

3.1
aperture
opening that defines the area over which average optical emission is measured

3.2
artificial lighting
lighting that is not provided by sunlight sources

3.3
circadian rhythm
characteristic periodic change in a living organism or life-related process

NOTE 1 A circadian rhythm is an approximate daily periodicity, a roughly 24-hour cycle in the biochemical, physiological or behavioural processes of living beings.

NOTE 2 Circadian rhythms may be influenced by optical radiation.

3.4
clear sky
cloudless sky

NOTE The relative luminance distribution is described in ISO 15469:2004/CIE S 011:2003.

3.5
colour rendering index
measure of the degree to which the psychophysical colour of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation

3.6
colour temperature
K
temperature of a black body (Planckian radiator) whose radiation has the same chromaticity as that of a given stimulus

NOTE Colour temperature is a characteristic of visible light that has important applications in lighting, photography, videography, publishing, and other fields. The colour temperature of a light source is determined by comparing its chromaticity with that of an ideal black-body radiator. The temperature (usually measured in kelvins, K) at which the heated black-body radiator matches the colour of the light source is that source's colour temperature; for a black body source, it is directly related to Planck's law and Wien's displacement law.

3.7
contrast
quantity (in the physical sense) intended to correlate with the perceived brightness contrast, usually defined by one of a number of formulae which involve the luminances of the stimuli considered

EXAMPLE $\Delta L/L$ near the luminance threshold, or L_1/L_2 for much higher luminances.

3.8
daylighting

practice of placing windows, or other openings, and reflective surfaces so that, during the day, natural light provides effective internal illumination

NOTE Particular attention is given to daylighting while designing a building when the aim is to maximize visual comfort or to reduce energy use. Energy savings can be achieved either from the reduced use of artificial lighting, or from passive solar heating or cooling.

3.9
diffuse reflected light
reflection of light from an uneven surface

NOTE The incident ray is reflected at a number of angles.

3.10
directionality
direction of incoming radiation determined by the direct part of it

3.11
disability glare
glare that impairs the vision of objects without necessarily causing discomfort

3.12
discomfort glare
glare that causes discomfort without necessarily impairing the vision of objects

3.13
energy performance
⟨of a building⟩ calculated or measured amount of weighted net delivered energy actually used or estimated to meet different needs associated with a standardized use of a building

NOTE This may include energy used for heating, cooling, ventilation, domestic hot water and lighting.

3.14
illuminance
⟨at a point of a surface⟩ quotient of the luminous flux d Φ_v incident on an element of the surface containing the point, divided by the area dA of that element

NOTE This is expressed in lux, 1 lx = 1 lm·m^{-2}.

3.15
life cycle cost
cost of an asset or its parts throughout its life cycle, while fulfilling the performance requirements

[ISO 15686-5:2008, definition 3.1.7]

3.16
life of a lamp
total time for which a lamp has been operated before it becomes useless, or is considered to be so according to specified criteria

3.17
light pollution
photopollution
luminous pollution
excessive or obtrusive artificial light

NOTE The International Dark-Sky Association defines light pollution as: Any adverse effect of artificial light including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste.

3.18
light trespassing
unwanted impingement of light from external light sources such as nearby building and street lights

3.19
lamp lumen maintenance factor
ratio of the luminous flux of a lamp at a given time in its life to its initial luminous flux, the lamp being operated under specified conditions

NOTE Lumen depreciation is typically expressed as lumen maintenance, the percentage of initial lumens remaining after a specified period of time.

3.20
luminance
L_v
⟨in a given direction, at a given point of a real or imaginary surface⟩ quantity defined by the following equation:

$$L_v = \frac{d^2\Phi_v}{dA \cdot \cos\theta \cdot d\Omega}$$

where

d Φ_v is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle, dΩ, containing the given direction;

dA is the area of a section of that beam containing the given point;

θ is the angle between the normal to that section and the direction of the beam

NOTE This is expressed in candela per square metre, 1 cd·m^{-2} = 1 lm·m^{-2}·sr^{-1}.

3.21
luminous efficacy
quotient of the luminous flux emitted by the power consumed by the source

3.22
luminous flux
quantity derived from the radiant flux by evaluating the radiation according to its action upon the CIE standard photometric observer

NOTE This is expressed in lumen lm.

3.23
luminous intensity distribution
distribution of luminous intensity having an axis of symmetry or at least one plane of symmetry

3.24
outdoor obstructions
anything outside a building which prevents the direct view of part of the sky

3.25
overcast sky
completely overcast sky for which the ratio of its luminance L_γ in the direction at an angle γ above the horizon to its luminance L_z at the zenith is given by the following equation:

$$L_\gamma = L_\mathrm{z}\,(1 + 2 \sin \gamma)/3$$

3.26
partly cloudy sky
sky having between 30 % and 70 % cloud cover (in daylighting)

3.27
reflectance
ratio of the reflected radiant or luminous flux to the incident flux in the given conditions

3.28
silhouette phenomenon
phenomenon in which a visual target looks dark when the background is too bright

3.29
sky luminance
luminance of a sky element

NOTE This is expressed in $\mathrm{cd \cdot m^{-2}}$.

3.30
skylight
visible part of diffuse sky radiation

3.31
sunlight
visible part of direct solar radiation

3.32
thermal radiation
process of emission in which the radiant energy originates in the thermal agitation of the particles of matter such as atoms, molecules, ions

3.33
transmittance
ratio of the transmitted radiant or luminous flux to the incident flux in the given conditions

3.34
transparency
capacity to transmit radiative energy without altering its incoming direction

3.35
visual nuisances
subjective visual discomfort caused by unwanted views

3.36
visual target
something to be seen and recognized by human eyes

3.37
window
daylight opening on a vertical or nearly vertical area of a room envelope

4 Fundamentals

4.1 General

General principles of indoor environment design allow the clients and design teams to provide the desired quality of indoor environment in a sustainable building according to the fundamentals of the design process.

The design process aims to ensure, by visual comfort, an efficient environmental building design providing the specified quality and performance level involving safety, health, comfort, and energy use as well as sustainability, the philosophy, ethics, and assumptions taken by the people concerned. Building designers should define the goals based on the requirements, constraints, and actual conditions to be achieved, integrating the owning and operating costs during the design stage.

4.2 Project information

The available project information that influences the development of visual comfort design concepts together with constraints and all requirements shall be documented. When assumptions are made in lieu of necessary information related to the standards or regulations for building environment visual comfort design, with respect to the indoor environment, these assumptions shall be documented. The project information provided by the users of this International Standard that influences the programming, development, and/or the design of building components and the building service systems, shall also be documented.

4.3 Framework of generation and verification

Architectural design and building system design are goal-driven activities. The routes necessary to achieve the end result are not straightforward, and must be flexible. In some instances, the assumptions are made under uncertain conditions. Hence, the design process involves the iteration of generation and verification. The generation process is a sub-process where a design solution is synthesized, while the verification process is another sub-process in which the design solution depends on different visual comfort design criteria.

4.4 Framework of documentation at approval

The evaluation and approval processes shall be documented. The documentation process shall explicitly state what is to be provided by the project. The evaluation and approval process shall demonstrate that the stated goals can be achieved. Every document provided shall describe the characteristics planned and verify whether they are actually achieved. Approval should be obtained at each design stage.

The documents issued during this design process shall cover the following questions:

— Is the stated definition adequate and feasible?

— Is the environmental design for visual comfort feasible?

— Is the specified structure expected to satisfy the constraints and requirements?

— Is the building capable of providing the visual comfort quality and performance required?

4.5 Harmonization of architectural and system design for visual comfort

Since architectural design as well as the building system design contributes to the realization of the indoor environment, the general principles of building environment design should be used to harmonize the architectural and system design for visual comfort.

The general principles of building environment for visual comfort design should not restrict creative architectural design. The principles do not predefine the order or precedence of individual tasks in both the architectural and building system design for visual comfort.

5 Design process

5.1 Stage I — Formulation of project definition

5.1.1 General

A high-performance and high-quality visual environment is one that:

— meets design objectives of visual environment;

— maximizes occupant visual comfort, well-being and productivity;

— minimizes occupant complaints;

— maximizes building values to the owner;

— yields a lifetime of energy performance of a building and reduces operating costs.

In order to design a high-performance and high-quality visual environment, an integrated architectural approach is recommended. The integrated approach addresses the critical interactions between the building façade (which admits heat and light), building interior and all light sources such as daylight (skylight and/or sunlight) and artificial light. This approach also shares appropriate decisions across the owner and the design team throughout the design process.

5.1.2 Project definition (requirements)

The phases of visual environment design typically comprise parallel architectural design work and might include programming, schematic (or preliminary) design, design development, contract documents, and construction administration.

Before beginning programming, items 5.1.2.1 through 5.1.2.6 shall be well understood.

