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Building environment design — Indoor environment — Design process for the 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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 16817:2012), which has been technically revised.

Introduction

ISO 16813 defines general principles for the design of building indoor environment and helps the main participants in the design process to ensure an indoor environment of the quality required for users.

The purpose of this document is to provide design team members with a design process for the indoor visual environment to aid provision of, in a sustainable approach, required visual comfort, physiological effects of light and energy performance of buildings. Visual comfort does not necessarily only provide a suitable lighting for executing a task. For example, a window has at least 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 takes into account human needs that include elements linked to performance, visual comfort, health, safety and well-being.

The objective of this document is to provide the design team at each phase of the design process with a way to implement the nine general principles of sustainability (NGPS) in buildings, as described in ISO 15392 and how to integrate these principles in their decision-making processes, in order to be part of a sustainable approach.

Concerning research in illuminating and lighting, work by the International Commission on Illumination (CIE) should be consulted. The existing CIE and CEN standards are used and any new work is performed in close coordination with CIE and CEN.

This document

— 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, and

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

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

  — 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;

  — 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 the visual environment

1 Scope

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

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.

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

ISO 26000, *Guidance on social responsibility*

3 Terms and definitions

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

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

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

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

3.1
artificial lighting
lighting that is provided by artificial light sources such as electric lights, candles, oil lamps and gas lights

3.2
circadian rhythm
biological rhythm with a period of approximately 24 h

[SOURCE: CIE S 017/E]

3.3
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

[SOURCE: CIE S 017/E]

3.4
daylighting
practice of placing *windows* (3.25) and/or *rooflights* (3.19), or other openings, and reflective surfaces so that, during the day, natural light provides internal illumination

Note 1 to entry: 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 from the reduced use of *lighting systems*.

3.5
daylight opening
area, glazed or unglazed, that is capable of admitting daylight to an interior

[SOURCE: CIE S 017/E]

3.6
design aids
set of guidelines used for conceptual details and final designs for the indoor environment, based on the requirements whether or not expressed by the client and stakeholders

[SOURCE: ISO 16813]

3.7
directionality
the quality of being directional

3.8
electric lighting
lighting by electric light sources

[SOURCE: CIE S 017/E]

3.9
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 1 to entry: This may include energy used for heating, cooling, ventilation, domestic hot water and lighting.

[SOURCE: ISO 16818]

3.10
obstruction
anything outside a building which prevents the direct view of part of the sky

[SOURCE: CIE S 017/E]

3.11
glare
condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of *luminance* (3.16), or by extreme contrasts

[SOURCE: CIE S 017/E]

3.12
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 1 to entry: This is expressed in lux, 1 lx = 1 lm·m^{-2}.

3.13
life cycle cost
cost of an asset or its parts throughout its life cycle, while fulfilling the performance requirements

3.14
light pollution
generic term indicating the sum total of all adverse effects of artificial light

[SOURCE: CIE S 017/E]

3.15
light trespass
unwanted impingement of light from external light sources such as nearby building and street lights

3.16
luminance
L_v
⟨in a given direction, at a given point of a real or imaginary surface⟩ quantity defined by the following formula:

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

where

$d\Phi v$ is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle, $d\Omega$, 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 1 to entry: This is expressed in candela per square metre, 1 $cd \cdot m^{-2}$ = 1 $lm \cdot m^{-2} \cdot sr^{-1}$.

[SOURCE: CIE S 017/E]

3.17
luminous flux
quantity derived from the radiant flux by evaluating the radiation according to its action upon the CIE standard photometric observer

Note 1 to entry: This is expressed in lumen lm.

[SOURCE: CIE S 017/E]

3.18
reflectance
ratio of the reflected radiant or *luminous flux* (3.17) to the incident flux in the given conditions

[SOURCE: CIE S 017/E]

3.19
rooflight
daylight opening (3.5) on the roof or on a horizontal surface of a building

[SOURCE: CIE S 017/E]

3.20
skylight
part of sky radiation capable of causing a visual sensation

[SOURCE: CIE S 017/E]

3.21
sunlight
part of direct solar radiation capable of causing a visual sensation

[SOURCE: CIE S 017/E]

3.22
transmittance
ratio of the transmitted *luminous flux* (3.17) to the incident flux in the given conditions

3.23
transparency
capacity to transmit radiative energy without altering its incoming direction

3.24
visual nuisances
subjective visual discomfort caused by unwanted views

3.25
window
daylight opening (3.5) on a vertical or nearly vertical area of a room envelope

[SOURCE: CIE S 017/E]

4 Fundamentals

4.1 General

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

The nine general principles of sustainability (NGPS) are defined in ISO 15392. The NGPS include

— continual improvement,

— equity,

— global thinking,

— holistic approach,

— involvement of interested parties,

— long-term consideration,

— precaution and risk,

— responsibility, and

— transparency.

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 project information that influences the development of visual environment design concepts, together with constraints and all requirements, shall be documented. A description of the intended use (and related requirements) of the building and end-user needs shall be included. When assumptions are made in lieu of necessary information related to the standards or regulations applicable to quality visual environment design, these assumptions shall be documented. The project information provided by the users of this document that influences the programming, development and/or the design of building components and the building service systems shall also be documented. The expected service life of the building and its components shall be specified.

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 should be flexible. In some instances, the assumptions are made under uncertain conditions. The design choices shall be focused on the limitation of adverse environmental impacts. Hence, an iterative generation process and verification and validation of the design decisions shall be established at each stage of the design process. When a decision is to be made, the design team shall make a systematic review of the potential effects of that decision during the life cycle of the building. 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 quality visual environment design criteria. The expected performance of the visual environment shall be achieved during the above processes. When the targets are not met, the design team shall determine acceptability and act accordingly. A periodic review of the management system shall be made in order to check effectiveness of existing management system and consider improvement as necessary.

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. Transparent decision-making and communication processes shall be established. Essential maintenance and replacement plans of the building components shall be documented according to the expected service life of the building. 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 quality visual environment feasible?

— Is the specified structure expected to satisfy the environmental, economic and social constraints and requirements?

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

4.5 Harmonization of architectural and system design for quality visual environment

Since quality indoor visual environment is the result of a harmonization between architectural design and technical, it is appropriate to apply the general principles of the indoor building environment design.

The general principles of building environment for quality visual environment 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 quality visual environment.

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 the design objectives of the visual environment,

— maximizes users' quality visual environment, well-being, health and productivity,

— minimizes users' complaints,

— maximizes building values to the owner,

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

— respects the sustainability policy of the client or main decision-maker: defines the key elements of the sustainability policy for the project, and

— ensures the safety of the users.

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 other lighting systems. This approach also shares appropriate decisions across the owner and the design team throughout the design process.

Efficient and responsible management throughout the process shall be implemented to establish early identification of needs and roles of interested parties, clear project organisation and planning at each phase, shared decision making, traceability, with good anticipation of risks, problems and conflicts.

Sustainability objectives should be taken into account accordingly with the project:

— **availability of resources (e.g. financial, technical, human, etc.):**

  — ensure the resources available for the project correspond to the ambitions of the project;

  — ensure the resources available for the operation and maintenance allow an optimal use of the buildings;

— **management of risks:**

  — anticipate the administrative, technical and human issues, through early planning in sufficient detail;

  — identify and assess the financial, social, environmental and technical risks, considering short-, medium- and long-term issues;

  — determine acceptability and act accordingly;

  — undertake a regular review;

— **formalization of contracts and responsibilities between parties:**

  — establish contracts suitable for the project and its specificities;

  — ensure that interfaces between actors are well organized and formalized;

— **achievement of the expected performance;**

— **learning from experience:**

  — benefit from past experiences or projects;

  — capitalize on present experience for continuous improvement;

— **consideration of a life cycle perspective**: bring into practice the life cycle thinking approach in the key stages of the project/process:

  — provision of information to successive actors to ensure they are aware of the initial principles, objectives, technical and architectural choices that are specific to the construction work, and the implications of these for its operation and its disposal at the end of life;

— **create record for the operating actors on critical features of the works that relate to sustainability issues.**

