INTERNATIONAL STANDARD

ISO 19454

First edition
2019-08

Building environment design — Indoor environment — Daylight opening design for sustainability principles in visual environment

Conception des bâtiments — Espace intérieur — Conception des prises du jour pour les principes de durabilité dans l'environnement visuel

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Reference number
ISO 19454:2019(E)

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Published in Switzerland

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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.

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

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.

Introduction

ISO 16813 provides general principles for the design of the indoor environment for buildings. The design process for the indoor visual environment is provided by ISO 16817 to ensure required visual comfort, good physiological effects of light and building energy performance and sustainability.

This document provides design team members with a design process for daylight openings under the umbrella of ISO 16813 and ISO 16817. Receiving daylight is a fundamental human need. It is essential to ensure favourable daylight environments in buildings. Daylight opening design is an indispensable element of building design. This document is targeted at habitable rooms in all buildings to ensure sufficient, quality daylight.

For this document, both windows and rooflights are deemed daylight openings. The size and position of the daylight openings affect the amount of daylight entering a room as well as the view from the daylight opening. An appropriate sizing of the daylight opening ensures a necessary level of daylight and an impression of spaciousness. However, large daylight openings can require more control of daylight in terms of visual and thermal environments. Qualities of daylight admitted through the daylight opening vary depending on the direction in which the daylight opening faces.

This document:

— provides a framework for taking into consideration various parameters and criteria in daylight opening design;

— is intended for use by design teams (architects and engineers), building clients, contractors, government officials and academics;

— is aimed at assisting these groups in designing daylight openings in the process of building design;

— incorporates sustainability considerations into the design of indoor visual environments.

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Building environment design — Indoor environment — Daylight opening design for sustainability principles in visual environment

1 Scope

This document provides a design process for daylight openings in order to ensure the principle of sustainability in the indoor visual environment. The design process for daylight openings includes the consideration of:

— sunshine duration in the building interiors;

— daylight opening ratio to the wall area of a habitable room;

— daylight opening ratio to the floor area of a habitable room;

— appropriate levels of indoor daylight based on human visual needs and the extent of sunlight;

— daylight control systems in the building;

— thermal comfort, thermal gains and energy efficiency.

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This document is applicable to building environment design for new buildings and the retrofit of existing buildings.

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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 8995-1, *Lighting of work places — Part 1: Indoor*

ISO 16817:2017, *Building environment design — Indoor environment — Design process for the visual environment*

3 Terms and definitions

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

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

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

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

3.1
commissioning
sequence of events that ensure the building and the *technical building systems* (3.16) are functioning in accordance with the design parameters for the building lifetime

[SOURCE: ISO 16813:2006, 3.7 modified — The word “HVAC” has been replaced with “technical building”.]

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3.2
daylight
part of global solar radiation capable of causing a visual sensation

[SOURCE: CIE S 017/E:2011, 17-278]

3.3
daylight opening
area, glazed or unglazed, that is capable of admitting *daylight* (3.2) to an interior

Note 1 to entry: Basic architectural forms of the daylight opening are illustrated in Annex B.

[SOURCE: CIE S 017/E:2011, 17-284, modified — Note 1 to entry has been added.]

3.4
daylight opening ratio
daylight opening ratio to the floor area
daylight opening ratio to the wall area of a habitable room
ratio of the daylight opening area to the corresponding floor or wall area of a habitable room

Note 1 to entry: "Window-to-wall ratio (WWR)" is defined as "ratio of the fenestration area to the gross exterior wall area" in ISO 16818:2008, 3.249[2].

3.5
design team
group of people who are responsible for building design

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Note 1 to entry: The design team can consist of an architect, an interior designer, a lighting designer, a landscape designer, engineers in electrical engineering, illuminating engineering, HVAC systems, structural engineering and construction management and other specialists.

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3.6
direct solar radiation
part of extra-terrestrial solar radiation which, as a collimated beam, reaches the earth's surface after selective attenuation by the atmosphere

Note 1 to entry: The quantity measured is the direct solar irradiance, expressed in $W \cdot m^{-2}$.

[SOURCE: ISO 9846:1993, 3.6, modified — The last sentence in the original definition has been changed to Note 1 to entry.]

3.7
habitable room
room that is continuously used for living, working, meeting, amusement and other purposes similar thereto

[SOURCE: ISO 18523-2:2018, 3.1.7]

3.8
possible sunshine duration
possible sunshine duration at a particular location
sum of the time intervals within a given time period during which the sun is above the real horizon

Note 1 to entry: The possible sunshine duration can be obscured by mountains, buildings, trees, etc.

[SOURCE: CIE S 017/E:2011, 17-972, modified — The last sentence in the original definition has been changed to Note 1 to entry.]

3.9
relative sunshine duration
ratio of *sunshine duration* (3.14) to *possible sunshine duration* (3.8) within the same time period

Note 1 to entry: The unit is 1.

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[SOURCE: CIE S 017/E:2011, 17-1086]

3.10
rooflight
skylight, US
daylight opening (3.3) in a flat roof or low-pitched roof, intended primarily for lighting and consisting of a frame and glazing

Note 1 to entry: In the US, there is a homograph for the term “skylight”. See 3.11.

[SOURCE: ISO 6707-1:2017, 3.3.3.13, modified — The words "construction for closing an" have been deleted and “daylight” has been added.]

3.11
roof window
skylight, US
daylight opening (3.3) in the plane of a pitched roof, which admits light and which can provide ventilation

Note 1 to entry: In the US, there is a homograph for the term “skylight”. See 3.10.

[SOURCE: ISO 6707-1:2017, 3.3.3.14, modified — The words "construction for closing an" have been deleted and “daylight” has been added.]

3.12
spaciousness
spatial largeness and extensiveness, especially inside a building

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3.13
sunlight
part of *direct solar radiation* (3.6) capable of causing a visual sensation

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[SOURCE: CIE S 017/E:2011, 17-1281]

3.14
sunshine duration
sum of time intervals within a given time period (hour, day, month, year) during which the irradiance from *direct solar radiation* (3.6) on a plane normal to the sun direction is equal to or greater than 120 $W \cdot m^{-2}$

[SOURCE: CIE S 017/E:2011, 17-1282]

3.15
sustainability
maintenance of ecosystem components and functions for future generations, to address economic efficiency, social issues and environmental preservation

[SOURCE: ISO 16813:2006, 3.27]

3.16
technical building system
technical equipment for heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting, building automation and control and electricity production

Note 1 to entry: A technical building system can refer to one or to several building services (e.g., heating, cooling, lighting and domestic hot water).

Note 2 to entry: A technical building system is composed of different sub-systems.

Note 3 to entry: Electricity production can include cogeneration, wind power and photovoltaic systems.

[SOURCE: ISO 52000-1:2017, 3.3.13, modified — The word “lighting” has been added in Note 1 to entry.]

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3.17
visual comfort
occupant satisfaction which the indoor visual environment, described in terms of illumination level, glare, visibility, reflection, quality view and psychological and physiological content with natural and artificial illumination

[SOURCE: ISO 16813:2006, 3.29, modified — The words “quality view” have been added.]

3.18
window
daylight opening (3.3) on a vertical or nearly vertical area of a room envelope

[SOURCE: CIE S 017/E:2011, 17-1436]

4 Fundamentals

4.1 General

Daylight opening design is a part of designing the indoor visual environment in the process of designing a building. It shall be appropriately included in the integrated design process provided by ISO 16817 in order to achieve the quality indoor visual environment. Daylight openings influence not only the visual environment but also the thermal, acoustical and air environments in buildings. An integrated multidisciplinary approach by a design team has important implications for daylight opening design. The integrated design process ensures an efficient and effective design to obtain the specified quality and performance level of safety, health, comfort and energy efficiency in buildings. ISO 16813 provides a flow diagram of the design process. The design process for daylight openings shall follow this process, as shown in Annex A. Daylight opening design shall be started at the initial stage of building design. Daylight can provide large quantities of light indoors, with great spectral quality and variability changing though the day and seasons. Windows provide a view and information about the outside and contribute to the psychological wellbeing of occupants. Windows, rooflights and roof windows can also provide exposure to sunlight indoors, which is important in e.g. dwellings, hospitals and nurseries. However, windows can give rise to glare. Careful consideration should be given to window screens, glazing materials and the reflectance of interior surfaces.

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Exposure to sunlight is an important criterion because sufficient exposure to sunlight contributes to human health and a sense of wellbeing; but some rooms have to avoid receiving sunlight for their functionality. Besides, sunlight often causes glare directly or indirectly. It is of consequence in workplaces. Adequate sunlight controls should be provided to avoid visual discomfort as well as an overheating problem.

A certain level of the sunshine duration should be ensured in a habitable room for wellbeing[3,4]. Regional characteristics of direct solar radiation are expressed by the possible sunshine duration and the relative sunshine duration. In high-latitude regions, it is difficult to receive sufficient direct solar radiation in winter. In equatorial regions, south- and north-facing façades receive less direct solar radiation, whereas east- and west-facing façades receive more during a day. Direct solar radiation incident on the building exterior should be considered at the early stages of design. Incorrect decisions about the geometrical shape of the building can prevent the admission of sunlight into rooms.

The performance of daylight openings is influenced by site characteristics. Large obstructions can have an impact both on the amount of light reaching daylight openings and on the daylight distribution within rooms, and subsequently on the indoor visual environment. The building shall be planned so that building interiors will be illuminated by daylight in accordance with need for satisfactory performance of visual tasks. One or more habitable rooms should receive sunlight except where unavoidable circumstances are produced by the surrounding conditions of the site.

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4.2 General principles of sustainability

ISO 16817 provides nine general principles of sustainability (NGPS) in designing the indoor visual environment following ISO 15392[5]. Daylight opening design shall follow these principles. The NGPS are:

— continual improvement;

— equity;

— global thinking;

— holistic approach;

— involvement of interested parties;

— long-term consideration;

— precaution and risk management;

— responsibility;

— transparency.

The NGPS are based on the concept of sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs from economic, environmental and social aspects[5]. Sustainable development of buildings brings about the required performance and functionality with minimum adverse environmental impact. It includes consideration of all components of the building from a single product to technical building systems for the life cycle.

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The continual improvement is recurring activity to enhance all aspects of sustainability. The equity encompasses balanced and objective consideration of intergenerational, interregional and intra-societal ethics. The global thinking encompasses consideration of regional and global consequences of acting locally. The holistic approach encompasses inclusion of all aspects of sustainability over the life cycle of the building. The involvement of interested parties encompasses consideration of contributions and requirements of interested parties relative to their respective areas of responsibility and the timing of their involvement. The long-term consideration encompasses short-, medium- and long-term implications in decision-making. The precaution and risk management encompass avoidance of risks and unfavourable impacts. The responsibility encompasses the moral responsibility for actions. The transparency encompasses presentation of the information in a manner that is open, comprehensive, understandable, and traceable with verifiable credibility.

The daylight opening and accompanying daylight control systems are important components of the building. ISO 16817 specifies that building designers should define goals based on the requirements, constraints and actual conditions, considering the owning and operating costs during the design stage. The design team should appropriately define goals for the daylight opening design.

4.3 Project information

ISO 16817 specifies that the available project information which influences the development of design concepts, together with constraints and all requirements, shall be documented at the beginning of a project. The project information also influences design concepts of daylight openings. A description of the intended use (and related requirements) of the building and end users' needs shall be included. The information on the local climate is fundamental to designing daylight openings as well as the building. When assumptions are made in lieu of necessary information related to the standards or regulations for the daylight opening design, these assumptions shall be documented.

4.4 Framework of generation and verification

Daylight opening design is a part of architectural design and building system design, which are goal-driven activities. In designing the building environment, the routes necessary to achieve the end result are not straightforward and shall be flexible. In some instances, the assumptions are made under

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uncertain conditions. The design choices shall be focused on the limitation of adverse environmental impacts. Hence, the design process involves the iteration of generation, verification and validation of the design decisions. Daylight opening design shall be included in the iterative design 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 on thermal, acoustic and visual comfort. The generation process is a sub-process where a design solution is found by synthesizing different requirements and constraints, while the verification process is another sub-process in which the design solution is rated against different design criteria. The expected performance of the daylight openings shall be achieved during the above processes. When the targets are not met, the design team shall determine the acceptability and act accordingly.

4.5 Framework of documentation at approval

The evaluation and approval processes shall be documented for the daylight opening design as well as the other factors in the project. 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 plans for maintenance of the daylight openings and the control systems shall be documented according to the expected service life of the building. Approval should be obtained at each design stage.

The documents issued during the design process for daylight openings shall cover the following questions:

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— Is the daylight opening design in compliance with regulation and standard requirements?

— Is the daylight opening design for the quality visual environment feasible?

— Is the specified daylight opening design expected to satisfy the environmental, economic and social constraints and requirements?

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— Is the daylight opening design capable of providing the performance required?

4.6 Harmonization of architectural and daylight opening design

Architectural design and the building system design influence the design and construction of the indoor visual environment. The daylight opening design is directly connected with the architectural design. The general principles of building environment design for visual comfort should support creative architectural design. The principles do not pre-define the order or precedence of individual tasks in both the architectural and daylight opening designs.

5 Design elements of daylight openings

5.1 General

In order to design a high-performance and high-quality visual environment, an integrated architectural approach is recommended. The daylight opening design shall be a part of this integrated approach that addresses the critical interactions among the building envelope (that admits heat and light), building interior and all light sources such as daylight (skylight and/or sunlight) and electric light. This approach also shares appropriate decisions across the owner and the design team throughout the design process.

ISO 16817 defines the design process to ensure the quality of the indoor visual environment. In designing daylight openings, the following elements should be taken into consideration at each stage of the design process:

— daylight opening ratio to the wall area of a habitable room;

— daylight opening ratio to the floor area of a habitable room;

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