INTERNATIONAL STANDARD

ISO 17772-1

First edition
2017-06

Energy performance of buildings — Indoor environmental quality —

Part 1: Indoor environmental input parameters for the design and assessment of energy performance of buildings

Performance énergétique des bâtiments — Qualité de l'environnement intérieur —

Partie 1: Paramètres d'entrée de l'environnement intérieur pour la conception et l'évaluation de la performance énergétique des bâtiments

Reference number
ISO 17772-1:2017(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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. 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. 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: http://www.iso.org/iso/foreword.html

This document was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*.

A list of all the parts in the ISO 17772 series can be found on the ISO website.

Introduction

Energy consumption of buildings depends significantly on the criteria used for the indoor environment (heating, cooling, ventilation and lighting) and building (including systems) design and operation. Indoor environment also affects health, productivity and comfort of the occupants. Recent studies have shown that costs of poor indoor environment for the employer, the building owner and for society, as a whole are often considerable higher than the cost of the energy used in the same building. It has also been shown that good indoor environmental quality can improve overall work and learning performance and reduce absenteeism. In addition uncomfortable occupants are likely to take actions to make themselves comfortable which may have energy implications. There is therefore a need for specifying criteria for the indoor environment for design and energy calculations for buildings and building service systems.

There exist other national and International Standards, and technical reports, which specify criteria for thermal comfort (ISO 7730[2]). These documents do specify different types and categories of criteria, which may have a significant influence on the energy demand. For the thermal environment criteria for the heating season (cold/winter) and cooling season (warm/summer) are listed. These criteria are, however, mainly for dimensioning of building, heating, cooling and ventilation systems. They may not be used directly for energy calculations and year-round evaluation of the indoor thermal environment. Studies have shown that occupant expectations in natural ventilated buildings may differ from conditioned buildings, which will be part of this document.

This document specifies how design criteria can be established and used for dimensioning of systems. It defines how to establish and define the main parameters to be used as input for building energy calculation and long term evaluation of the indoor environment. Finally this document identifies parameters to be used for monitoring and displaying of the indoor environment

Different categories of criteria may be used depending on type of building, type of occupants, type of climate and national differences. This document specifies several different categories of indoor environment which could be selected for the space to be conditioned. These different categories are intended to be used for design and may also be used to give an overall, yearly evaluation of the indoor environment by evaluating the percentage of time in each category. The designer may also select other categories using the principles from this document.

Table 1 shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1[15].

NOTE 1 In ISO/TR 52000-2 the same table can be found, with, for each module, the numbers of the relevant EPB standards and accompanying technical reports that are published or in preparation.

NOTE 2 The modules represent EPB standards, although one EPB standard can cover more than one module and one module can be covered by more than one EPB standard, for instance a simplified and a detailed method respectively. See also Clause 2 and Tables A.1 and H.1.

Table 1 — Position of this document within the EN EPB set of standards according to ISO 52001-1

Overarching		**Building** (as such)		**Technical Building Systems**										
	Descrip-tions		Descrip-tions		Descrip-tions	Heat-ing	Cool-ing	Ventila-tion	Humid-ifi cation	Dehumidifi-cation	Domes-tic hot water	Light-ing	Building automa-tion and control	PV, wind, ..
sub1	M1	sub1	M2	sub1		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General	1	General	1	General									
2	Common terms and definitions; symbols, units and subscripts	2	Building energy needs	2	Needs									
3	Applica-tions	3	(Free) Indoor conditions without systems	3	Maximum load and power									
4	Ways to express energy perfor-mance	4	Ways to express energy perfor-mance	4	Ways to express energy perfor-mance									
5	Building functions and build-ing bound-aries	5	Heat transfer by transmis-sion	5	Emission and con-trol									
6	Building occupan-cy and operating conditions	6	Heat transfer by infiltra-tion and ventilation	6	Distribu-tion and control									
7	Aggre-gation of energy services and energy carriers	7	Internal heat gains	7	Storage and con-trol									
8	Building partition-ing	8	Solar heat gains	8	Genera-tion and control									
9	Calculated energy perfor-mance	9	Building dynamics (thermal mass)	9	Load dispatch-ing and operating conditions									
10	Measured energy perfor-mance	10	Measured energy perfor-mance	10	Measured energy perfor-mance									
11	Inspection	11	Inspection	11	Inspection									

Table 1 *(continued)*

Overarching			Building (as such)		Technical Building Systems										
	Descriptions			Descriptions		Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic hot water	Lighting	Building automation and control	PV, wind, ..
12	Ways to express indoor comfort				12	BMS									
13	Outdoor environment conditions														
14	Economic calculation														

Energy performance of buildings — Indoor environmental quality —

Part 1: Indoor environmental input parameters for the design and assessment of energy performance of buildings

1 Scope

This document specifies requirements for indoor environmental parameters for thermal environment, indoor air quality, lighting and acoustics and specifies how to establish these parameters for building system design and energy performance calculations.

It includes design criteria for the local thermal discomfort factors, draught, radiant temperature asymmetry, vertical air temperature differences and floor surface temperature.

This document is applicable where the criteria for indoor environment are set by human occupancy and where the production or process does not have a major impact on indoor environment.

It also specifies occupancy schedules to be used in standard energy calculations and how different categories of criteria for the indoor environment can be used.

The criteria in this document can also be used in national calculation methods. This document sets criteria for the indoor environment based on existing standards and reports (listed in Clause 2 and the Bibliography).

The document does not specify design methods, but gives input parameters to the design of building envelope, heating, cooling, ventilation and lighting.

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 13731, *Ergonomics of the thermal environment — Vocabulary and symbols*

IEC 60050-845, *International electrotechnical vocabulary — Chapter 845: Lighting*

EN 16798-3, *Ventilation of non-residential buildings — Performance requirements for ventilation and room-conditioning systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13731 and IEC 60050-845, and the following 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
EPB standard
standard that complies with the requirements given in ISO 52000-1, CEN/TS 16628[19] and CEN/TS 16629[20]

Note 1 to entry: These three basic EPB documents were developed under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480,), and support essential requirements of EU Directive 2010/31/EU on the energy performance of buildings (EPBD). Several EPB standards and related documents are developed or revised under the same mandate.

[SOURCE: ISO 52000-1:2017, 3.5.14]

3.2
adaptation, thermal
physiological, psychological or behavioural adjustment of building occupants to the interior thermal environment in order to avoid or to limit thermal discomfort

Note 1 to entry: In naturally ventilated buildings these are often in response to changes in indoor environment induced by outdoor weather conditions.

3.3
adaptation
perceived air quality
sensory adaptation to perceived air quality (odour), which occurs during the first 15 min exposure to bio effluents

3.4
airing
intentional opening of windows, doors, vents, etc. for increasing the ventilation in a room

3.5
breathing zone
part of the occupied zone at the head level of the occupants

Note 1 to entry: Head level is 1,7 m standing, 1,1 m seated and 0,2 m for children on the floor

Note 2 to entry: For a definition of occupied zone see EN 16798–3.

3.6
building, very low-polluting
building where predominantly very low-emitting materials and furniture are used, activities with emission of pollutants are prohibited and no previous emitting sources (like tobacco smoke, from cleaning) were present

Note 1 to entry: Default criteria are listed in Annex H.

3.7
building, low-polluting
building where predominantly low emitting materials are used and materials and activities with emission of pollutants are limited

Note 1 to entry: Note to entry: Default criteria are listed in in Annex H.

3.8
building, non low-polluting
building where no effort has been done to select low-emitting materials and where activities with emission of pollutants are not limited or prohibited

Note 1 to entry: Default criteria are listed in Annex H. Previous emissions (like tobacco smoke) can have taken place.

3.9
cooling season
part of the year (usually summer) during which cooling is needed to keep the indoor temperature within specified levels, at least part of the day and in part of the rooms

Note 1 to entry: The length of the cooling season differs substantially from country to country and from region to region.

3.10
daylight factor
ratio of the illuminance at a point on a given plane due to the light received directly or 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, excluding the contribution of direct sunlight to both illuminances

3.11
demand controlled ventilation
ventilation system where airflow rates are controlled automatically according to measured needs at room level

3.12
dehumidification
process of removing water vapour from air

3.13
outdoor temperature, daily mean
average of the hourly mean outdoor air temperature for one calendar day (24 h)

3.14
outdoor temperature running mean
$\boldsymbol{\Theta_{ed}}$
exponentially weighted running mean of the daily mean outdoor air temperature

3.15
heating season
part of the year during which heating is needed to keep the indoor temperature within specified levels, at least part of the day and in part of the rooms

Note 1 to entry: The length of the heating season differs substantially from country to country and from region to region.

3.16
humidification
process of adding water vapour to air to increase humidity

3.17
mechanical cooling
cooling of the indoor environment by mechanical means used to provide cooling of supply air

Note 1 to entry: This includes fan coil units, cooled surfaces, etc.

Note 2 to entry: Opening of windows during night and day time or mechanical supply of cold outdoor air is not regarded as mechanical cooling.

3.18
mechanical ventilation
ventilation system where air is supplied or extracted from the building or both by a fan using air terminal devices, ducts and roof/wall devices

3.19
natural ventilation
ventilation provided by thermal, wind, or diffusion effects through doors, windows, or other intentional devices in the building designed for ventilation

Note 1 to entry: Natural ventilation systems can be either manually or automatically controlled.

3.20
occupied hours
hours when the majority of the building or part of the building being considered is in its intended use

3.21
operative temperature
uniform temperature of an imaginary black enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the actual non-uniform environment

Note 1 to entry: Further information is given in ISO 7726[1] and EN 16798-2[13].

3.22
optimal operative temperature
operative temperature that satisfies the greatest percentage of occupants at a given clothing and activity level in the current thermal environment

3.23
room conditioning system
system installed and used to keep comfortable conditions in a room within a defined range

Note 1 to entry: Air conditioning, chilled beams and radiant surface heating and cooling systems are included.

3.24
ventilation
process of providing outdoor air by natural or mechanical means to a space or building

3.25
ventilation rate
magnitude of outdoor air flow to a room or building through the ventilation system or device

3.26
ventilation system
combination of appliances or building components designed to supply indoor spaces with outdoor air and/or to extract polluted indoor air

Note 1 to entry: A ventilation system can refer to mechanical, natural and hybrid ventilation systems.

Note 2 to entry: The ventilation system can consist of mechanical components (e.g. combination of air handling unit, ducts and terminal units). A ventilation system can also refer to natural ventilation systems making use of temperature differences and wind with facade grills in combination with mechanical exhaust (e.g. in corridors, toilets etc.). A combination of mechanical and natural ventilation is possible (hybrid systems).

3.27
design ventilation airflow rate
ventilation rate that the ventilation system is able to provide in design conditions (including boost, weather and loads)

4 Symbols and abbreviations

4.1 Symbols

For the purposes of this document, the symbols given in ISO 52000-1:2017, Annex C and the following apply.

Symbol	Quantity	Unit
θ_o	indoor operative temperature	°C
θ_e	outdoor temperature	°C
Θ_{m}	running mean outdoor air temperature	°C
Θ_{o}	operative temperature, design and energy calculations	°C
$\Theta_{\mathrm{rm\text{-}i}}$	running mean outdoor temperature	°C
$\Theta_{\mathrm{ed\text{-}i}}$	daily mean outdoor temperature	°C
v_{a}	air speed (average / maximum)	m/s
Θ_{f}	floor surface temperature	°C
ΔCO_2	concentration	ppm
$\Delta\Theta_{\mathrm{pr}}$	radiant temperature asymmetry	K
$\Delta\Theta_{\mathrm{a}}$	vertical air temperature difference	K
α	constant for running mean calculations	
q_{tot}	total ventilation rate	l/s
q_{B}	ventilation rate for building materials	l/s(m^2)
q_{p}	ventilation rate for persons	l/s (per person)
$q_{\mathrm{tot,oz}}$	total ventilation rate in occupied zone	l/s(m^2), l/s(person)
n	number of persons	
q_{h}	ventilation rate required for dilution of pollutant	L/s
G_{h}	generation of a pollutant	µg/s
C_{h}	guideline value of a pollutant	µg/L
$C_{\mathrm{h,i}}$	guideline value of the substance	µg /m^3
$C_{\mathrm{h,o}}$	supply concentration of a pollutant at air intake	µg/L
ε_{v}	ventilation effectiveness	-
A	floor area	m^2
$L_{p,A}$	A-weighed sound pressure level	dB(A)
$L_{\mathrm{eq,\,nT,A}}$	equivalent continuous sound pressure level	dB(A)
D	daylight factor	
$DC_{\mathrm{a},j}$	daylight quotient of the calculated area	j
E_{m}	average maintained illuminance	lx
M	activity level	met
l_{cl}	assumed clothing level winter/summer	clo

4.2 Abbreviations

For the purposes of this document, the abbreviations given in ISO 52000-1:2017, Annex C and the following apply.

Abbreviation	Term
ACH	
DR	draught rate, %
DSNA	daylight quotient sunscreen not activated
IEQ	indoor environmental quality
IEQ_{cat}	indoor environmental quality category for design
LPB_{1-3}	low polluting building class
PD	percentage dissatisfied for local; thermal discomfort
PMV	predicted mean vote
PPD	predicted percentage of dissatisfied, %
RH	relative humidity
WHO	World Health Organization

5 Interactions with other standards

The present document provides default indoor environmental criteria for the design of buildings, room conditioning systems and lighting systems (see Clause 6). The thermal criteria (PMV or design indoor temperature in winter, design indoor temperature in summer) shall be used as bases for the definition of input for heating load calculations and cooling load calculations, sizing of equipment and energy calculations. Ventilation rates shall be used for design, sizing and energy calculations for ventilation systems. Lighting levels shall be used for design of lighting system including the use of day lighting. The present document shall provide default values for the indoor environment (like temperature, ventilation rate, illuminance) as input to the calculation of the energy demand (building energy demand), when the space is occupied (see Clause 7).

NOTE The categories are related to the level of expectations the occupants might have. A normal level would be “Medium”. A higher level might be selected for occupants with special needs (children, elderly, handicapped, etc.). A lower level does not provide any health risk but might decrease comfort.

6 Design input parameters for design of buildings and sizing of heating, cooling, ventilation and lighting systems

6.1 General

For design of buildings and sizing of technical building systems for heating, cooling, ventilation and lighting parameters and criteria shall be specified and documented. The criteria given in this clause shall be used as input values for sizing of the systems as well as for design of buildings.

The present document specifies, in informative annexes, default input values for use in cases where no national regulation is available. The default criteria are given for several categories. Design criteria for the indoor environment shall be documented together with the premises for use of the spaces.

Default input values are given for each of the different categories of indoor environmental quality. A short description of the categories is shown in Table 2.

Table 2 — Categories of indoor environmental quality

Category	Level of expectation
IEQ_I	High
IEQ_{II}	Medium
IEQ_{III}	Moderate
IEQ_{IV}	Low

NOTE The categories are related to the level of expectations the occupants might have. A normal level would be "Medium". A higher level might be selected for occupants with special needs (children, elderly, handicapped, etc.). A lower level will not provide any health risk but might decrease comfort.

6.2 Thermal environment

6.2.1 Heated and/or mechanically cooled buildings

For establishing design criteria the following procedure shall be used.

Criteria for the thermal environment in heated and/or mechanical cooled buildings shall be based on the thermal comfort indices PMV-PPD, with assumed typical levels of activity and typical values of thermal insulation for clothing (winter and summer). Based on the selected criteria a corresponding design operative temperature interval shall be established. The values for dimensioning of cooling systems shall be the upper values of the comfort range during cooling season (summer) and values for dimensioning of the heating system shall be the lower values of the comfort range.

The design criteria in this section shall be used for both design of buildings (dimensioning of windows, solar shading, building mass etc.) and HVAC systems.

Selection of the category is building, zone or room specific, and the needs of special occupant groups such as elderly people (low metabolic rate and impaired control of body temperature) shall be considered. For this group of people it is recommended to use category I requirements.

For buildings and spaces were the mechanical cooling capacity is not adequate to meet the required temperature categories, the design documents shall state that fact.

NOTE 1 Some default examples of recommended design indoor operative temperatures for heating and cooling, derived according to this principle, are presented in Table H.2 and in ISO/TR 17772-2[14].

NOTE 2 Instead of using operative temperature as the design criterion the PMV-PPD index can be used directly. In this way the effect of increased air velocity and effect of dynamic clothing insulation can be taken into account.

NOTE 3 Using one of the default methods described in ISO/TR 17772-2, it can be described how often the conditions are out of the required range.

6.2.1.1 Local thermal discomfort

Criteria for local thermal discomfort such as draught, radiant temperature asymmetry, vertical air temperature differences and floor surface temperatures shall also be taken into account when designing buildings and HVAC systems. Table H.3 presents the most important local thermal discomfort criteria at three category levels.

NOTE 1 For more background information see ISO/TR 17772-2.

6.2.2 Buildings without mechanical cooling

For the dimensioning of the heating system the same criteria as for mechanically, cooled and heated buildings shall be used (see 6.1.1).