



BSI Standards Publication

Energy performance of buildings — Indoor environmental quality

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

National foreword

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**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*





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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

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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. www.iso.org/directives

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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										
	Descriptions		Descriptions		Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic hot water	Lighting	Building automation 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	Applications	3	(Free) Indoor conditions without systems	3	Maximum load and power									
4	Ways to express energy performance	4	Ways to express energy performance	4	Ways to express energy performance									
5	Building functions and building boundaries	5	Heat transfer by transmission	5	Emission and control									
6	Building occupancy and operating conditions	6	Heat transfer by infiltration and ventilation	6	Distribution and control									
7	Aggregation of energy services and energy carriers	7	Internal heat gains	7	Storage and control									
8	Building partitioning	8	Solar heat gains	8	Generation and control									
9	Calculated energy performance	9	Building dynamics (thermal mass)	9	Load dispatching and operating conditions									
10	Measured energy performance	10	Measured energy performance	10	Measured energy performance									
11	Inspection	11	Inspection	11	Inspection									

Table 1 (continued)

Overarching		Building (as such)		Technical Building Systems										
	Descriptions		Descriptions		Descriptions	Heat- ing	Cool- ing	Ventila- tion	Humid- ifi- cation	Dehumidifi- cation	Domes- tic hot water	Light- ing	Building automa- tion and control	PV, wind, ..
12	Ways to express indoor comfort			12	BMS									
13	Outdoor envi- ronment 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**

θ_{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
θ_{rm-i}	running mean outdoor temperature	°C
θ_{ed-i}	daily mean outdoor temperature	°C
v_a	air speed (average / maximum)	m/s
θ_f	floor surface temperature	°C
ΔCO_2	concentration	ppm
$\Delta \theta_{pr}$	radiant temperature asymmetry	K
$\Delta \theta_a$	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)
$q_{tot,oz}$	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
$C_{h,i}$	guideline value of the substance	µg /m ³
$C_{h,o}$	supply concentration of a pollutant at air intake	µg/L
ε_v	ventilation effectiveness	-
A	floor area	m ²
$L_{p,A}$	A-weighted sound pressure level	dB(A)
$L_{eq, nT,A}$	equivalent continuous sound pressure level	dB(A)
D	daylight factor	
$DC_{a,j}$	daylight quotient of the calculated area	j
E_m	average maintained illuminance	lx
M	activity level	met
I_{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 where 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).

In buildings without mechanical cooling, the criteria for the thermal environment shall be specified using the method described in 6.1.1 or using the adapted method that takes into account adaptation effects. This adaptive method only applies for occupants with sedentary activities without strict clothing policies where thermal conditions are regulated primarily by the occupants through opening and closing of elements in the building envelop (e.g. windows, ventilation flaps, roof lights, etc.). This method applies to office buildings and other buildings of similar type used mainly for human occupancy with mainly sedentary activities, where there is easy access to operable windows and occupants can freely adapt their clothing to the indoor and/or outdoor thermal conditions.

NOTE 1 The field studies behind the method were conducted in office buildings but the method can also apply in other spaces with similar individual possibilities for adaptation, e.g. in residential buildings.

NOTE 2 Default criteria for the indoor operative temperature in buildings without mechanical cooling systems are presented in [H.2](#).

The upper limits shall be used to design buildings and passive thermal controls (e.g. orientation of glazing and solar shading, thermal building capacity, size and adjustability of operable windows etc.) to avoid overheating.

For buildings and spaces where the building design and the natural ventilation system is not adequate to meet the required temperature categories the design documents shall state that fact.

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

6.2.3 Increased air velocity

It shall be evaluated if increased air velocity (with or without personal control) can improve thermal comfort.

NOTE Under summer comfort conditions with indoor operative temperatures >25 °C increased air velocity can be used to reduce the adverse effects of increased air temperatures according to [H.3](#).

6.3 Design for indoor air quality (ventilation rates)

6.3.1 General

Indoor air quality shall be controlled by the following means: source control, ventilation, and possible filtration and/or air cleaning.

Design ventilation airflow rates intended for sizing of the ventilation system shall be specified.

NOTE 1 Default ventilation airflow rates are presented in [Annex B](#).

NOTE 2 During normal operation of the ventilation system, the ventilation flow rates can be different from the design ventilation flow rates.

6.3.1.1 Source control

The control of emission of non-human pollutants shall be the primary strategy for maintaining acceptable air quality.

NOTE 1 Once the main sources of pollutants are identified they can be eliminated or decreased by ventilation.

NOTE 2 The choice of building materials, surface preparation, maintenance and furniture has an impact on the non-human pollutant emission in rooms, spaces and buildings. The classification of this is shown in [Annex C](#).

6.3.1.2 Ventilation

The design ventilation air flow rates shall be used for designing any type of ventilation system, including mechanical, natural and hybrid ventilation systems.

The design requirements for the ventilation air flow rates shall take into account the pollutant emissions rates left after source control with material selection, local exhaust and other means.

6.3.1.3 Time periods used for determining air flow rates

The methods described in [Clause 6](#) assume that pollutants emissions are constant in each time period considered and lead to a constant ventilation air flow rate for each time period.

If occupation and pollutant loads vary in time, the designer shall specify the time periods considered for the calculation of the design ventilation air flow rates. These shall describe at least the assumed periods of occupancy and of non-occupancy.

NOTE Ventilation is also needed during non-occupied hours of the building to avoid accumulation of pollutant in indoor air or on surfaces, or ventilation can be started before occupancy (see ISO/TR 17772-2). [Annex N](#) includes default occupant schedules.

6.3.1.4 Building damage

Building damage shall be evaluated if the required ventilation rate for indoor air quality is high enough to avoid damaging condensation on surfaces, in the materials or in the structure. If not a higher ventilation rate shall be used as design value.

6.3.1.5 Design documentation

The design documentation shall state:

- which design method and if applicable which IEQ_{cat} is used for design;
- which pollutant sources have been identified and processes used to eliminate or decrease those sources;
- which method has been used to derive the specified design ventilation airflow rates and the applied occupancy schedules;
- design flow rates and the control range of ventilation in l/s per m² and l/s per occupant.

NOTE Default occupant schedules are given in [Annex N](#).

6.3.2 Methods

6.3.2.1 General

Design parameters for indoor air quality shall be derived using one or more of the following methods:

- Method 1: Method based on perceived air quality;
- Method 2: Method using limit values for substance concentration;
- Method 3: Method based on predefined ventilation air flow rates.

NOTE Within each method, the designer can choose between different categories of indoor environmental quality and define which low pollutant building category, LPB₁₋₃, [Annex C](#) or [Annex J](#) is used.

6.3.2.2 Method 1 based on perceived air quality

The dilution required for reducing the health risk from a specific air pollutant shall be evaluated separately from the ventilation rates required to obtain a desired perceived air quality level (see Table 4). The highest of these ventilation rate values shall be used for design. If critical sources are identified for health, it shall be checked that they remain below the health threshold values (see [6.3.2.3](#)).

The total ventilation rate for the breathing zone is found by combining the ventilation for people and building calculated from [Formula \(1\)](#):

$$q_{\text{tot}} = n \cdot q_p + A_R \cdot q_B \quad (1)$$

where

- q_{tot} is the total ventilation rate for the breathing zone, l/s;
- n is the design value for the number of the persons in the room;
- q_p is the ventilation rate for occupancy per person, l/(s·person);
- A_R is the floor area, m²;
- q_B is the ventilation rate for emissions from building, l/(s·m²).

The perceived air quality levels are defined by default for non-adapted persons in non-residential and adapted persons in residential buildings. In non-residential buildings, assuming adapted persons shall be justified.

NOTE See [Annex B](#) for default values. The methods described in ISO/TR 17772-2 can be used in special cases where adapted persons are considered. The resulting ventilation rates are assumed to be independent of seasons.

6.3.2.3 Method 2 using criteria for individual substances

The design ventilation rate required to dilute an individual substance shall be calculated using [Formula \(2\)](#):

$$Q_h = \frac{G_h}{C_{h,i} - C_{h,o}} \cdot \frac{1}{\varepsilon_v} \quad (2)$$

where

- Q_h is the ventilation rate required for dilution, in m³/s;
- G_h is the generation rate of the substance, in µg/s;
- $C_{h,i}$ is the guideline value of the substance, in µg/m³;
- $C_{h,o}$ is the concentration of the substance of the supply air, in µg/m³;
- ε_v is the ventilation effectiveness.

NOTE 1 Default values for $C_{h,i}$ can be found in [Annex B](#) (for CO₂) and [Annex F](#) (other substances). Default values for ε_v (complete mixing is 1) can be found in EN 16798-3. $C_{h,i}$ and $C_{h,o}$ can also be expressed as ppm 10⁶ (V/V). In this case the pollution load G_h needs to be expressed as l/s.

[Formula \(2\)](#) applies to steady-state conditions and the method requires that the supply air substance concentration is lower than the indoor concentration.

To calculate the design ventilation air flow rate from [Formula \(2\)](#), the most critical or relevant pollutant (or group of pollutants) shall be identified and the pollution load in the space shall be estimated.

When this method is used it is required that CO₂ representing the pollutant emission from people (bio effluents) shall be used as one of the substances.

Values depending on the category of indoor air are defined for CO₂ in [Annex B](#). Threshold values for other sources are listed in [Annex E](#). Emission rates and outdoor concentrations for the substances

considered shall be defined based on material testing or certification (see [Annex J](#)) and local ambient air quality values.

NOTE 2 ISO/TR 17772-2 shows examples of pollutants generation and concentration (e.g. for CO₂ or water vapour, together with sample calculations) as well as calculations for non-steady-state.

6.3.2.4 Method 3 based on pre-defined ventilation air flow rates

This is a method to determine certain pre-defined minimum ventilation air flow rate estimated to meet requirements for both perceived air quality and health in the occupied zone.

The pre-defined ventilation air flow rates shall be expressed by one or more of the following parameters:

- total design ventilation for people and building components (q_{tot});
- design ventilation per unit floor area (q_{m^2});
- design ventilation per person (q_{p});
- design air change rates (a_{ch});
- design air flow rates by room and building type (q_{room}).

NOTE Default values for q_{m^2} and q_{p} are presented in [Annex I](#). Design opening areas (A_{tot}) can for residential buildings be considered as predefined air flow rates but need specific data on local climate and building characteristics (see EN 16798-7^[43]).

6.3.3 Non-residential buildings

6.3.3.1 Applicable methods

For the design of ventilation systems and calculation of design heating and cooling loads, the design ventilation rate shall be specified based on national requirements, or when no national regulation is available, using one of the three methods described in 6.2.2.1.

6.3.3.2 Ventilation air flow rates during unoccupied periods

In case the ventilation is shut off, the operation time and ventilation air flow rate needed to limit the concentration of pollutants emitted by materials prior to occupation shall be determined.

NOTE 1 [Annex I](#) gives default values for the minimum ventilation air to be delivered prior to occupation.

In case the air flow rate is lowered, the air flow rate needed to limit the concentration of pollutants emitted by materials prior to occupation shall be determined.

NOTE 2 [Annex I](#) gives default values for the minimum ventilation air flow rate to be delivered to remove building emissions during un-occupied hours.

6.3.4 Residential buildings

6.3.4.1 Applicable methods

Design ventilation air flow rates shall be specified as an air change per hour for each room, and/or outdoor air supply per person and/or required extract rates (bathroom, toilets, and kitchens), given as an overall required air-change rate or design air flow rates by room and building type (q_{room}) and design opening areas.

NOTE Design opening areas (A_{tot}) for residential buildings can be considered as predefined air flow rates but need specific data on local climate and building characteristics (see EN 16798-7).

6.3.4.2 Ventilation air flow rates during non-occupied periods

If the ventilation rate is lowered when the building is not occupied, the air flow rate needed to limit the concentration of pollutants emitted by any sources (building and specific residential activities) shall be determined and applied.

NOTE Default values are listed in Table I.1.4.

6.3.5 Access to operable windows

It shall be possible to access operable elements in the building envelop (e.g. windows, ventilation flaps, sky lights) provided for the ventilation, to allow the building occupants to make ventilation and to provide contact to the outside. Alternatively a remote control e.g. by mechatronic drives or operating rods can be used.

NOTE For example, this applies to bedrooms and living rooms in dwellings and other buildings with rooms intended for sleep, e.g. elderly homes. It also applies in schools and child care facilities. Increased air flow rates can be determined according to EN 16798-7. For further guidance see ISO/TR 17772-2.

6.3.6 Filtration and air cleaning

The influence of the position of outdoor air intakes, filtration and air cleaning shall be considered. If filtration and air cleaning is used the following points shall be considered:

- reducing the amount of airborne pollutants (pollens, moulds, spores, particles, dust) from the outdoor air intake by circulating the air through a filter or similar device;
- circulating secondary air through a filter or other air cleaning technology to reduce the amount of pollutants in the indoor air;
- reduce the concentration of odours and gaseous contaminants by circulating the secondary air or recirculating the return air through a gas phase air cleaner.

NOTE Design guidelines on air cleaning and filtration are given in EN 16798-3 and ISO 16814^[12]. How to partially substitute ventilation by air cleaning is described in ISO/TR 17772-2.

6.4 Humidity

The humidity criteria depend partly on the requirements for thermal comfort and indoor air quality and partly on the physical requirements of the building (condensation, mould growth etc.). For special buildings (museums, historical buildings, churches etc.) additional humidity requirements shall be taken into account. Humidification or dehumidification of room air is usually not required but, if used, excess humidification and dehumidification shall be avoided.

NOTE 1 Air-water systems might require dehumidification to prevent condensation.

NOTE 2 Default design values of indoor humidity for occupied spaces with dehumidification and humidification systems are given in [1.2](#).

6.5 Lighting

6.5.1 General

To enable people to perform visual tasks efficiently and accurately, appropriate lighting shall be provided. The lighting criteria shall be selected according to the tasks and activities being undertaken and shall provide comfortable conditions for the occupants. The design illuminance levels shall be obtained by means of daylight, electric light or a combination of both.

The design of daylight openings (e.g. windows, rooflights, etc.) shall not cause visual discomfort due to glare or a loss of privacy. The heat load from lighting systems shall be taken into account when calculating the energy demand in non-residential buildings for heating and cooling.

NOTE Windows are to be the primary source of light during daylight hours. Windows also provide visual contact with the outside environment. For reasons of comfort and energy in most cases the use of daylight is preferred. This depends on factors like occupancy hours, autonomy (portion of occupancy time during which there is enough daylight), location of the building (latitude) and amount of daylight hours during summer and winter, etc. Some explanations of the effects of lighting on health are given in ISO/TR 17772-2.

6.5.2 Non-residential buildings

For work places the design level for the average maintained illumination E_m shall be specified.

NOTE Specifications for work places can be found in EN 12464-1^[23] and for sports lighting in EN 12193^[21]. For some visual tasks in buildings and spaces the required lighting criteria are presented in [Table D.1](#). Emergency lighting is not within the scope of this document.

To ensure good daylight provision, the daylight penetration in the spaces meant for human occupancy shall be fulfilled.

NOTE EN 15193-1^[30] provides details of occupancy periods and daylight availability and estimations. Default daylight criteria are given in [Annex D](#).

6.5.3 Residential buildings

The design illuminance levels shall be obtained by means of daylight, electric light or a combination of both.

NOTE EN 15193-1 and CEN/TR 15193-2^[18] provide details of occupancy periods and daylight availability and estimations. Default daylight criteria are given in B.4.

6.6 Noise

For the design of ventilation, heating and cooling systems the required sound levels shall be specified.

NOTE 1 Default values are listed in [Annex E](#). The tables in Annex E are only based on noise due to building service equipment and not on outdoor noise. Often national requirements exist for noise from building service equipment inside or outside assuming windows are closed. Calculation methods and guidance for the evaluation of noise at the design stage are found in EN 12354-5^[22].

The noise from building service systems might disturb the occupants and prevent or deteriorate the intended use of the space or building. The noise in a space shall be evaluated using A-weighted equivalent sound pressure level, normalized with respect to reverberation time ($L_{Aeq,nT}$) to take into account the sound absorption of the room.

NOTE 2 $L_{Aeq,nT}$ is defined in ISO 16032^[11] and ISO 10052^[5].

NOTE 3 Noise from the ventilation and air conditioning systems can also be used to mask the other sound sources and to improve the acoustic privacy.

The criteria shall be used to limit the sound pressure level due to mechanical equipment and to set sound insulation requirements for the noise from outside and adjacent rooms.

NOTE 4 The values recommended in [Annex E](#) can be exceeded for a short-term period if the occupants can control the operation of the equipment or the windows. Even in this case, the rise of the sound pressure level over the values in the Annex E is limited to between 5 dB (A) and 10 dB (A).

Ventilation shall not rely primarily on operable windows if the building is located in an area with a high outdoor noise level compared to the level to be achieved in the space inside the building.