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English Version

Energy performance of buildings - Part 3: Ventilation for non-residential buildings - Modules M5-1, M5-4 - Performance requirements for ventilation and room-conditioning systems

Performance énergétique des bâtiments - Partie 3: Ventilation dans les bâtiments non résidentiels - Modules M5-1, M5-4 - Exigences de performances pour les systèmes de ventilation et de climatisation

Energetische Bewertung von Gebäuden - Teil 3: Lüftung von Nichtwohngebäuden - Module M5-1, M5-4 - Leistungsanforderungen an Lüftungs- und Klimaanlagen und Raumkühlsysteme

This draft European Standard is submitted to CEN members for formal vote. It has been drawn up by the Technical Committee CEN/TC 156.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (FprEN 16798-3:2017) has been prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Formal Vote.

This standard has been produced to meet the requirements of Directive 2010/31/EU 19 May 2010 on the energy performance of buildings (recast), referred to as “recast EPDB”.

This document will supersede EN 13779:2007, which was produced to meet the requirements of Directive 2002/91/EC 16 December 2002 on energy performance of buildings referred to as “EPBD”.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

For the convenience of Standards users CEN/TC 156, together with responsible Working Group Conveners, have prepared a simple table below relating, where appropriate, the relationship between the ‘EPBD’ and ‘recast EPBD’ standard numbers prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”.

EPBD EN Number	Recast EPBD EN Number	Title
EN 15251	EN 16798-1	Energy performance of buildings — Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics – Module M1-6 (revision of EN 15251)
N/A	CEN/TR 16798-2	Energy performance of buildings — Part 2: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics — Module M1-6 — Technical report — interpretation of the requirements in EN 16798-01
EN 13779	EN 16798-3	Energy performance of buildings — Part 3: Ventilation for non-residential buildings — Modules M5-1, M5-4 — Performance requirements for ventilation and room-conditioning systems (revision of EN 13779)
N/A	CEN/TR 16798-4	Energy performance of buildings — Part 4: Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems — Technical report — interpretation of the requirements in EN 16798-03
EN 15241	EN 16798-5-1	Energy performance of buildings — Part 5-1: Ventilation for buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Calculation methods for energy requirements of ventilation and air conditioning systems (revision of EN 15241) —method 1

EN 15241	EN 16798-5-2	Energy performance of buildings — Part 5-2: Ventilation for buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Calculation methods for energy requirements of ventilation systems — Part 5-2 Distribution and generation (revision of EN 15241) — method 2
N/A	CEN/TR 16798-6	Energy performance of buildings — Part 6: Ventilation for buildings — Modules M5-6, M5-8, M 6-5, M6-8 , M7-5, M7-8 — Calculation methods for energy requirements of ventilation and air conditioning systems; technical report- interpretation of the requirements in EN 16798-05-1 and EN 16798-05-2
EN 15242	EN 16798-7	Energy performance of buildings — Part 7: Ventilation for buildings — Module M5-1, M5-5, M5-6, M5-8 — Calculation methods for the determination of air flow rates in buildings including infiltration (revision of EN 15242)
N/A	CEN/TR 16798-8	Energy performance of buildings — Part 8: Ventilation for buildings — Module M5-1, M5-5, M5-6, M5-8 — Calculation methods for the determination of air flow rates in buildings including infiltration. Technical report — interpretation of the requirements in EN 16798-07
EN 15243	EN 16798-9	Energy performance of buildings — Part 9: Ventilation for buildings — Modules M4-1, M4-4, M4-9 — Calculation methods for energy requirements Calculation methods for energy requirements of cooling systems — General (revision of EN 15243)
N/A	CEN/TR 16798-10	Energy performance of buildings — Part 10: Ventilation for buildings — Modules M4-1, M4-4, M4-9 — Calculation methods for energy requirements Calculation methods for energy requirements of cooling systems — Part 10: General — Technical report — interpretation of the requirements in EN 16798-09
N/A	EN 16798-13	Energy performance of buildings — Part 13: Module M4-8 — Calculation of cooling systems — Generation
N/A	CEN/TR 16798-14	Energy performance of buildings — Part 14: Module M4-8 — Calculation of cooling systems — generation — Technical report — interpretation of the requirements in EN 16798–13
N/A	EN 16798-15	Energy performance of buildings — Part 15: Module M4-7 — Calculation of cooling systems — storage
N/A	CEN/TR 16798-16	Energy performance of buildings — Part 16: Module M4-7 — Calculation of cooling systems — storage — Technical report — interpretation of the requirements in EN 16798–15

EN 15239 and EN 15240	EN 16798-17	Energy performance of buildings — Part 17: Ventilation for buildings — Module M4-11, M5-11, M6-11, M7-11 — Guidelines for inspection of ventilation and air-conditioning systems
N/A	CEN/TR 16798-18	TR 16798-18: Energy performance of buildings — Part 18: Ventilation for buildings — Module M4-11, M5-11, M6-11, M7-11 — Guidelines for inspection of ventilation and air-conditioning systems — Technical report — interpretation of the requirements in EN 16798–17

The revision concerns mainly the following aspects:

— New structure to clarify designing and calculation aspects;

— Update of filtration aspects;

— Update of heat recovery aspects and leakages in these systems;

— Clear coordination with prEN 16798-1:2015, outdoor air volume flows have been shifted to prEN 16798-1:2015;

— All indoor air quality aspects have been deleted, supply air quality have been introduced;

— Aspects of energy performance have been updated;

— Update of definitions of systems;

— Update of SPF definitions and links to EU 327/2014 regulation;

— The document was split in a normative part, containing all the normative aspects and a supplementary technical report containing additional information and informative annexes;

— The standard allows a normative national annex;

— The standard was updated to cover hourly/monthly/seasonal time-step.

Introduction

This European Standard is part of a series of standards aiming at international harmonization of the methodology for the assessment of the energy performance of buildings, called "set of EPB standards".

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

All EPB standards provide a certain flexibility with regard to the methods, the required input data and references to other EPB standards, by the introduction of a normative template in Annex A and Annex B with informative default choices.

For the correct use of this European Standard a normative template is given in Annex A to specify these choices. Informative default choices are provided in Annex B.

The main target groups of this European Standard are all the users of the set of EPB standards (e.g. architects, engineers, regulators).

Use by or for regulators: In case the standard is used in the context of national or regional legal requirements, mandatory choices may be given at national or regional level for such specific applications. These choices (either the informative default choices from Annex B or choices adapted to national / regional needs, but in any case following the template of this Annex A) can be made available as national annex or as separate (e.g. legal) document (national data sheet).

NOTE So in this case:

— the regulators will specify the choices;

— the individual user will apply the standard to assess the energy performance of a building, and thereby use the choices made by the regulators.

Topics addressed in this European Standard can be subject to public regulation. Public regulation on the same topics can override the default values in Annex B of this standard. Public regulation on the same topics can even, for certain applications, override the use of this European Standard. Legal requirements and choices are in general not published in standards but in legal documents. In order to avoid double publications and difficult updating of double documents, a national annex may refer to the legal texts where national choices have been made by public authorities. Different national annexes or national data sheets are possible, for different applications.

It is expected, if the default values, choices and references to other EPB standards in Annex B are not followed due to national regulations, policy or traditions, that:

— national or regional authorities prepare data sheets containing the choices and national or regional values, according to the model in Annex A. In this case the national annex (e.g. NA) refers to this text;

— or, by default, the national standards body will consider the possibility to add or include a national annex in agreement with the template of Annex A, in accordance to the legal documents that give national or regional values and choices.

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the Technical Report accompanying this standard (FprCEN/TR 16798-4, under preparation).

This European Standard also provides requirements especially for designers, installers, manufacturers, building owners and users, on ventilation, air-conditioning and room-conditioning systems in order to achieve a comfortable and healthy indoor environment in all seasons with acceptable installation and running costs. This European Standard focuses on the system-aspects for typical applications and covers the following:

— Aspects important to achieve and maintain a good energy performance in the systems without any negative impact on the quality of the indoor environment.

— Definitions of design and performances data.

1 Scope

This European Standard applies to the design, energy performance of buildings and implementation of ventilation, air conditioning and room conditioning systems for non-residential buildings subject to human occupancy, excluding applications like industrial processes. It focuses on the definitions of the various parameters that are relevant for such systems.

The guidance for design given in this European Standard and accompanying FprCEN/TR 16798-4 are mainly applicable to mechanical supply and/or exhaust ventilation systems. Natural ventilation systems or natural parts of hybrid ventilation systems are not covered by this European Standard. Reference is made to the Technical Report for informative guidance on the design of such systems.

Applications for residential ventilation are not dealt with in this European Standard. Performance of ventilation systems in residential buildings are dealt with in EN 15665 and CEN/TR 14788.

The classification uses different categories. For some values, examples are given and, for requirements, typical ranges with default values are presented. The default values given in this European Standard are not normative as such, and should be used where no other values are specified. Classification should always be appropriate to the type of building and its intended use, and the basis of the classification should be explained if the examples given in the European Standard are not to be used.

NOTE 1 Different standards may express the categories for the same parameters in a different way, and also the category symbols may be different.

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

NOTE 2 In FprCEN 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 3 The modules represent EPB standards, although one EPB standard may cover more than one module and one module may 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 B.1.

[1] In preparation.

Table 1— Position of this standard (in casu M5-1, M5-4), within the modular structure of the set of EPB standards

Overarching		Building (as such)		Technical Building Systems										
	Descriptions		Descriptions		Descriptions	Heating	Cooling	Ventilation	Humidifi cation	Dehumidification	Domestic Hot water	Lighting	Building automation & control	PV, wind, ..
sub1	**M1**	**sub1**	**M2**	**sub1**		**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**
1	General	**1**	General	**1**	General			EN 16798-3						
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 Performanc e			EN 16798-3						
5	Building Functions and Building Boundaries	**5**	Heat Transfer by Transmission	**5**	Emission & control									
6	Building Occupancy and Operating Conditions	**6**	Heat Transfer by Infiltration and Ventilation	**6**	Distribution & control									
7	Aggregation of Energy Services and Energy Carriers	**7**	Internal Heat Gains	**7**	Storage & control									
8	Building Partitioning	**8**	Solar Heat Gains	**8**	Generation & 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 Performanc e									
11	Inspection	**11**	Inspection	**11**	Inspection									
12	Ways to Express Indoor Comfort			**12**	BMS									
13	External Environment Conditions													
14	Economic Calculation													

NOTE The shaded modules are not applicable.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 308, *Heat exchangers — Test procedures for establishing performance of air to air and flue gases heat recovery devices*

EN 779, *Particulate air filters for general ventilation — Determination of the filtration performance*

EN 1822-3, *High efficiency air filters (EPA, HEPA and ULPA) — Part 3: Testing flat sheet filter media*

EN 1886, *Ventilation for buildings — Air handling units — Mechanical performance*

EN 12599:2012, *Ventilation for buildings — Test procedures and measurement methods to hand over air conditioning and ventilation systems*

EN 12792:2003, *Ventilation for buildings — Symbols, terminology and graphical symbols*

EN 13053:2006+A1:2011, *Ventilation for buildings — Air handling units — Rating and performance for units, components and sections*

EN 15780, *Ventilation for buildings — Ductwork — Cleanliness of ventilation systems*

prEN 16798-1:2015, *Energy performance of buildings — Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics — Module M1-6*

EN ISO 7345:1995, *Thermal insulation — Physical quantities and definitions (ISO 7345:1987)*

EN ISO 52000-1, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures (ISO/FDIS 52000-1)*[2]

Default references to EPB standards other than EN ISO 52000-1[3] are identified by the EPB module code number and given in Annex A (normative template) and Annex B (informative default choice).

NOTE Example of EPB module code number: M5-5, or M5-5.1 (if module M5-5 is subdivided), or M5-5/1 (if reference to a specific clause of the standard covering M5-5.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12792:2003, M1-6 and M1-9, EN ISO 7345:1995, EN ISO 52000-1[4], and the following apply.

The terms of EN ISO 52000-1[5] that are indispensable for the understanding of the underlying standard are repeated here.

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[2] In preparation.

[3] In preparation.

[4] In preparation.

3.1
EPB standard
standard that complies with the requirements given in EN ISO 52000-1[6], CEN/TS 16628 and CEN/TS 16629

Note 1 to entry CEN/TS 16628 and CEN/TS 16629 contain specific rules to ensure overall consistency, unambiguity, transparency and flexibility, supported by common templates. EN ISO 52000-1[7], the overarching EPB standard, is indispensable for each EPB standard, because of the modular structure, common terms and definitions, symbols and subscripts and because it provides the general framework for the EPB assessment.

[SOURCE: EN ISO 52000-1[8]]

3.2
room conditioning system
combination of appliances designed to keep comfort conditions in a room within a defined range

Note 1 to entry: Air conditioning systems as well as surface based systems, such as embedded systems, chilled ceilings and chilled beams, are included.

3.3
occupied zone
volume designed for human occupancy specified by horizontal and vertical planes

3.4
ventilation effectiveness
performance of air diffusion system in removing the pollutants from the occupied zone of a room given by relation between the pollution concentrations in the supply air, the extract air and the indoor air in the breathing zone (within the occupied zone)

3.5
specific fan power
amount of electric fan power divided by the air volume flow

3.6
demand controlled ventilation
ventilation system where the ventilation rate is controlled by air quality, moisture, occupancy or some other indicator for the need of ventilation

3.7
ventilation system
combination of appliances designed to supply interior spaces with outdoor air and to extract polluted indoor air

Note 1 to entry: The system can consist of mechanical components (e.g. combination of air handling unit, ducts and terminal units). 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.). Both mechanical and

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[5] In preparation.

[6] In preparation.

[7] In preparation.

[8] In preparation.

natural ventilation can be combined with operable windows. A combination of mechanical and non-mechanical components is possible (hybrid systems).

3.8
Exhaust Air Transfer Ratio (EATR)
level of carry over of extract air to the supply air

3.9
Outdoor Air Correction Factor (OACF)
ratio of outdoor air mass flow (ODA) and supply air mass flow (SUP)

3.10
design nominal air flow condition
declared nominal air volume flow at a density of 1,2 kg m^{-3}

3.11
reference load condition for air handling units
filter pressure drop of clean filters, dry heat exchangers and humidifiers at reference condition

3.12
air conditioning system
combination of appliances designed to supply conditioned air to a space

3.13
reference conditions P_{SFP}
reference conditions for pressure drop are: Clean filters and dry conditions for other components (e.g. heat exchanger, cooling coil and humidifier)

3.14
design load condition P_{SFPd}
design load condition for pressure drop are: Average of clean filters and recommended maximum pressure drop and for other components (heat exchanger, cooling coil, humidifier, etc.) the average of dry and wet values

4 Symbols and subscripts

4.1 Symbols

For the purposes of this document, the symbols given in Clause 4 and Annex C of EN ISO 52000-1[9], EN 12792 and the specific symbols listed in Table 2 apply.

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[9] In preparation.

Table 2 — Symbols and units

Quantity	Symbol	Unit
Pressure difference	Δp	Pa
Temperature difference	$\Delta\theta$ [a]	K
Ventilation effectiveness	ε_v	-
Coefficient of Performance	ε	-
Temperature	θ	°C
Air temperature in the room	θ_a	°C
Mean radiant temperature	θ_r	°C
Operative temperature	θ_o	°C
Density	ρ	$kg.m^{-3}$
Heating or cooling load	Φ	W
Temperature ratio	Φ_t	-
Area	A	m^2
Costs	C	€ [b]
Concentration	c	$mg.m^{-3}$
Specific heat capacity at constant pressure	c_p	$J.kg^{-1}.K^{-1}$
Diameter	d	m
Energy consumption (measured)	E	J
Energy demand (calculated)	E	J
Filter Efficiency (total, stage)	E_t; E_s	-
Efficiency	η	-
Specific primary energy use of ventilation	E_p	$W\ h\ m^{-3}\ h\ a^{-1}$
Exhaust Air Transfer Ratio	$EATR$	-
Specific leakage	f	$m^3.s^{-1}.m^{-2}$
Primary Energy Factor	f_P	-
Present value factor	f_{pv}	-
Height	h	m
Initial Investment	I	€ [b]
Thermal insulation of clothing	I_{cl}	clo
Length	L	m
Metabolic rate (activity)	M	met
Life span	n	Years
Humidity load	$\dot{m}$	$kg\ s^{-1}$
Building air change rate at 50 Pa pressure difference	n_{50}	h^{-1}
Fan power	P	W
Specific fan power	P_{SFP}	$W.m^{-3}.s$
Outdoor Air Correction Factor	$OACF$	-
Present value	PV	€ [b]
Pressure	p	Pa
Thermal Energy	Q	kWh
Mass flow rate	q_m	$kg.s^{-1}$
Volume flow rate	q_v	$m^3.s^{-1}$
Interest rate	r	-

Quantity	Symbol	Unit
Time	t	s
Volume	V	m^3
Air velocity	v	$m.s^{-1}$
Specific volume of supply air	v_{sup}	m^3 kg^{-1}dry air
Auxiliary Energy	w	kWh
Specific humidity	x	kg kg^{-1} dry air

a EN 12792 prefers θ but t and T may be used as well.

b Or National currency.

4.2 Subscripts

For the purposes of this document, the subscripts given in Clause 4 and Annex C of EN ISO 52000-1[10] apply.

5 Brief description of the method and routing

5.1 Output of the method

This European Standard contains designing aspects in Clauses 6 to 8, and EPB calculation aspects in Clause 9.

5.2 General description of the method

5.2.1 Input data for energy calculation

Data in Table 3 is describing input data for EPB calculations.

[10] In preparation.

Table 3— Input data for energy calculation

Name	Symbol	Unit	Validity interval	Ref	Varying
Ventilation rate per person	$q_{V,P}$	l/s m^3/h l/(sm^2) m^3/(hm^2)	0 - ∞	M1-6	no
Ventilation rate for building emission	$q_{V,B}$	l/s m^3/h l/(sm^2) m^3/(hm^2)	0 - ∞	M1-6	no
breathing zone ventilation	$q_{V,bz}$	l/s m^3/h l/(sm^2) m^3/(hm^2)	0 - ∞	M1-6	no
specific heating energy required for outdoor air treatment	q_{H}	Wh/(m^3/h·a)	0 - ∞	M5-6-1	no
Delivered energy factor heat	f_{H}	-	0 – 1	M3-9	no
specific cooling energy required for outdoor air treatment	q_{C}	Wh/(m^3/h·a)	0 - ∞	M5-6-1	no
Delivered energy factor cold	f_{C}		0 – 1	M4-8	no
specific humidification generation input	e_{HU}	Wh/(m^3/h·a)	0 - ∞	M6-8	no
Primary energy factor humidifier	$F_{\mathrm{P,cr}}$		0 – 1	M6-8	no
primary energy factors electricity	$f_{\mathrm{p,S}}$		0 – 1	M1-9	no
primary energy factors heating	$f_{\mathrm{p,H}}$		0 – 1	M4-9	no

5.2.2 Source of data for energy calculation

Input data about products that are required for the calculation described in this standard shall be the data supplied by the manufacturer if they are declared according to relevant EN product standards. If such data are not declared by the manufacturer or if the required data are not product data (system data etc.), default values are given in Annex B.

Default data given in Annex B may be replaced by other data, for example nationally determined data. To ensure consistency with this calculation method, input data shall be presented according to the template given in Annex A.

NOTE Compliance with the template given in Annex A does not guarantee that the new data set is consistent.

6 Output data for energy calculation

Data in Table 4 is describing output data for EPB calculations.

Table 4 — Output data for energy calculation

Name	Symbol	Unit	Range	Intended destination	Varying
average demand controlled air volume flow	$q_{V,dc}$	l/s m^3/h l/(sm^2) m^3/(hm^2)	0 - ∞	M5-2	no
ventilation outdoor air volume flow	$q_{V;ODA}$	l/s m^3/h l/(sm^2) m^3/(hm^2)	0 - ∞	M5-2	no
Specific fan power	P_{SFP}	$W.m^{-3}.s$	0 - ∞	M5-2 M5-6 M5-10	no
overall fan motor efficiency	η_e [11]	-	0 - 1	M5-6 M5-10	no
Heat recovery coefficient of performance	ε	-	0 – 1	M5-6	no
Heat recovery energy efficiency	η_e [12]	-	0 – 1	M5-6	no
Heat recovery temperature ration	η_t	-	0 – 1	M5-2	no
Heat recovery humidity ratio	η_h	-	0 – 1	M5-2	no
primary energy performance HVAC unit	$E_{P,V}$	Wh/(m^3/h·a)	0 - ∞	M5-9 M5-10	no

7 Indoor environment

7.1 General

Ventilation, air-conditioning or room-conditioning systems influence the following parameters:

— thermal environment;

— indoor air quality;

— indoor air humidity;

— acoustic environment.

NOTE The comfort and the performance of persons in a room is also dependent on other influences such as: type of work and configuration of working place, lighting and colours, size of room, furniture, view to the outside, working conditions and working relationships and individual factors.

The design assumptions for the indoor environment are based on design agreements. Typical design assumptions are given in 8.3 to 8.7, more basic information including categories and default values about the

[11] Symbol according to EU 327/2011.

[12] Symbol according to EN 13053.

design criteria in M1-6 and further guidance on air quality is given in 8.7 and 8.8. The agreed requirements for the thermal environment, indoor air quality, indoor air humidity and the acoustic environment are valid for occupied zone as defined in 7.2 only. A system shall be designed for the specific needs of the project.

7.2 Occupied zone

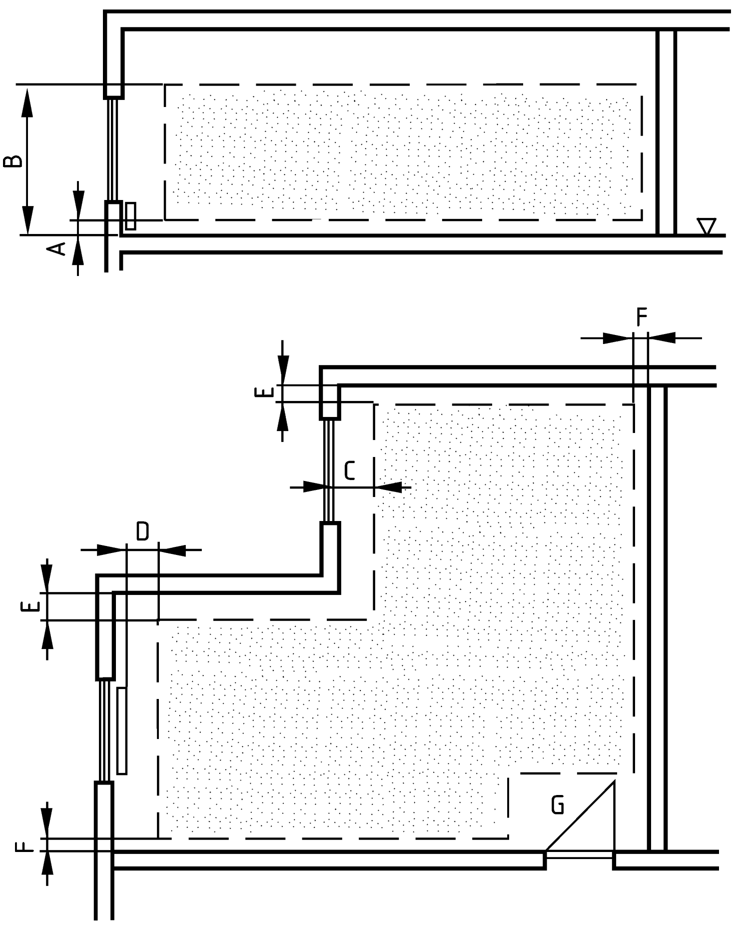
The requirements for the indoor environment shall be satisfied in the occupied zone. This means that all measurements dealing with comfort criteria shall be related to this zone. The total area of a room can be used to evaluate the requirements, but the comfort criteria are not guaranteed beyond the occupied zone.

The occupied zone is dependent on the geometry and the use of the room and shall be specified case by case.

Typical dimensions for the occupied zone are given in Table 5 and indicated in Figure 1.

Table 5 — Dimensions for the occupied zone

Distance from the inner surface of		Typical range (m)	Default value (m)
Floors (lower boundary)	A	0,00 to 0,20	0,05
Floors (upper boundary)	B	1,30 to 2,00	1,80
External windows and doors	C	0,50 to 1,50	1,00
HVAC appliances	D	0,50 to 1,50	1,00
External walls	E	0,15 to 0,75	0,50
Internal walls	F	0,15 to 0,75	0,50
Doors, transit zones etc.	G	Special agreement	-



Key

A vertical section

B plan view

Figure 1 — Description of the occupied zone

Special agreements should also be considered for the following types of zone, in which it could be difficult to meet the requirements to the thermal environment, especially with respect to draught and temperature:

a) transit zones;

b) zones close to doors that are often used or open;

c) zones close to supply air terminals;

d) zones close to units with high heat production or airflow rate.

Except when indicated or agreed otherwise, zones a) and b) are not considered part of the occupied zone, but zones c) and d) are considered part of the occupied zone.

If the use of a room is not based on the room dimensions but on other factors, the occupied zone can be defined according to the arrangement of working areas and equipment therein or by the location of the breathing zone.

8 Agreement of design criteria

8.1 General

The design criteria specify the information needed to design the system. These criteria also constitute the basis for the measurements that shall be carried out during the hand-over process. They provide the common language between all the parties including the client, designer, contractor and the operation and maintenance personnel.

Information necessary to design the system is organised on the basis of various documents outlined in 8.3 to 8.13. If the method used for dimensioning the system requires more details, they shall be provided.

Calculation procedure for the energy requirements of the ventilation and air conditioning system is presented in M5-6-1, M5-5, M4-1, M4-4, M4-9, M4-3, M4-3, M4-8 considering M1-9.

8.2 Principles

Although in this standard the terms “client”, “designer” or “contractor” are used to describe the function, the responsibilities are dependent on the contract. The use of these terms does not presuppose any definition of responsibility for the information. Nevertheless, if one party does not provide the information, the other shall ask for it or make and record the necessary assumptions. All key design decisions shall be agreed and documented.

The description of the characteristics of the environment and the structure of the building shall be obtained for design. The desired results required at the time of hand-over and during normal operation shall be specified and documented.

The description of the building with construction data, use and requirements is an evolving process with an increasing degree of detail and accuracy with the evolution of the project. Therefore the use of all specifications shall always be stated clearly. The details about the information needed are also dependent on the calculation method that is employed.

A classification system for the use of the building entities (M1-6) and specifying the requirements (according to this standard) shall be used throughout the design.

The design requirements of all entities and usage schemes shall be specified according to this standard.

8.3 General building characteristics

8.3.1 Location, outdoor conditions, neighbourhood

Information about the location of the relevant building, the significant neighbourhood characteristics such as adjacent buildings, shading, reflections, emissions, roads, airfields, sea coast, special requirements and all other information that influence the building design shall be specified in design. The category of outdoor air shall be defined in accordance with Table 8.

8.3.2 Design weather data

Information shall be given on climate data; as a minimum, design conditions for winter and summer are required, as well as annual data for energy calculation. The most important climate parameters for the design are:

— Winter: outdoor temperature and wind velocity;

— Summer: outdoor temperature, humidity and solar radiation.

The climate data (like a reference year, monthly or seasonal data) shall be defined in order to estimate annual energy consumption. Additional information on extreme conditions is needed to check the capacity of the system and the thermal comfort, especially possible over heating in summer. prEN 16798-1:2015 provides more information about application.

8.3.3 Information on the operation of the building

The occupancy profile during typical days, annual periods of non-occupancy (e.g. schools etc.), and on general operational use (e.g. weekend, night etc.) shall be specified by using the principles of M1-6 or by using national requirements.

8.4 Construction data

All building parts shall be specified with their relevant construction data.

8.5 Geometrical description

The geometrical description including information about the orientation of the elements exposed to the outdoor environment with impact on ventilation or thermal loads (for example windows, doors, openings, shadings, walls) shall be presented, and this can be done in the form of drawings and/or tables. The specification of the net volume and floor area, room by room, is recommended.

8.6 Use of the rooms

8.6.1 General

The information about the use of each room, or group of rooms with similar use shall be given, preferably in a table.

NOTE Further information on FprCEN/TR 16798-4 and EN 12599:2012, A.1.

8.6.2 Human occupancy

The number of people constitutes a basic condition of use because the ventilation outdoor air volume flow shall be designed for this level of occupancy.

The occupancy level shall be given as schedule, for example by specifying hourly occupancy values including the activity and clothing (see M1-6).

8.6.3 Internal heat gains

Internal heat gains (people, lighting and equipment) shall be specified for the various rooms or group of rooms. The gains shall be defined as follows:

— sensible gains, convective or radiative

— latent gains.

They shall be defined as schedules similar to occupation.

NOTE FprCEN/TR 16798-4 gives further information on internal loads.

8.6.4 Internal pollution and moisture sources

The category of the building (polluting class of the building), shall be defined in accordance with prEN 16798-1:2015. Special pollution or moisture production in a room shall be defined when relevant, with reference to the maximum limits on these pollutants that may be encountered inside the room. Each pollutant shall be defined by its schedule of emission and by the limit value to be admitted.

8.6.5 Given extract airflow

In some applications the extract airflow is given by the kind of process or equipment. In this case the extract airflow, the position and the design of the extract equipment shall be defined.

8.7 Requirements in the rooms

8.7.1 General

The requirements (desired results according to 8.1 to 8.3) and internal loads shall be specified room by room. The requirements with respect to thermal conditions and draught shall be satisfied in the occupied zone, specified in accordance with M1-6.

8.7.2 Type of control

The type of control of the indoor environment by means of the ventilation system shall be specified according to the definitions given in Table 12, and it shall be adapted to the use of the room.

8.7.3 Thermal comfort

The thermal conditions in the room shall be specified in accordance with M1-6 (human occupancy) and building and system relevant aspects.

The criteria for draft in the occupied zone shall be specified according to M1-6.

8.7.4 Air quality for people

The level of air quality required, and the method of classification applied shall be specified. The necessary air flow rates to achieve the specified requirements shall be calculated according to M1-6. The ventilation concept to reach the specified air volume flows shall be specified and designed.

8.7.5 Noise level

The noise due to the ventilation and air-conditioning equipment shall not generate unacceptable noise level to the indoor and outdoor environment.

NOTE Guidance is given in FprCEN/TR 16798-4, A.16.

Maximum allowable sound pressure level in the room shall be specified. Typical values are given in M1-6.

8.7.6 Lighting

The impact of lighting on the design on ventilation and room conditioning systems shall be considered. Typical values for lighting levels are given in M1-6 and M9.

NOTE Lighting power requirements are given in M9.

8.8 System requirements

The relevant system requirements shall be specified.

NOTE It is advised that the system requirements also conform to existing national regulations, including those for structural fire safety and the regulations related to acoustics.

The system requirements typically include:

— location of air intake and discharge openings. (see FprCEN/TR 16798-4);

— air filtering and filter selection see 9.7;

— application of humidification and dehumidification see Table 11;

— aspects of heat recovery see 9.6;

— re-use of extract air see 9.2.1;

— thermal insulation of the system see 8.9;

— protection from harmful moisture and condensation see 8.9;

— airtightness of the system see 9.8.6;

— aspects of cleanliness and hygiene of the components and system (see EN 15780);

— pressure conditions within the system and the building, taking into account the building and system airtightness (9.4);

— electrical power consumption (based on pressure drop and efficiency of systems and components) (9.5);

— space requirements for components and systems (see FprCEN/TR 16798-4);

— aspects to installation, operation and maintenance (see EN 15780);

— instrumentation for performance check (see EN 12599).

8.9 Heat transmission of surfaces of ventilation systems

The air distribution systems shall be insulated to minimize thermal losses and to avoid condensation in the system, where is a risk of condensation on the inner or outer surface of the duct system or components. The need for and level of insulation of ductwork shall take into account the potential heat losses and the condensation risk.

NOTE Further guidance is given in FprCEN/TR 16798-4.

The heat transmission of surfaces of ventilation systems between heat recovery unit and the target conditioned spaces shall be calculated according to M5-6-1 and M5-6-2.

8.10 General requirements for control adjustment and monitoring

The method for the control, adjustment and monitoring of all the systems shall be specified. The system shall be designed and installed so that the airflows can be measured and balanced according to the requirements.

The monitoring of the energy consumption shall allow a periodic check of the energy consumption of important individual systems and of the whole building. Therefore a measuring concept shall be identified at an early stage of the project and the necessary measuring devices installed. The controls system shall be specified according to M10. Changes of uses and requirements should be followed by adaptations of the system.

8.11 General requirements for maintenance and safety of operation

The system and each of the components shall be arranged, designed and installed to allow an energy efficient and hygienically operation and maintenance. Sufficient space for maintenance, cleaning operations, dismounting and repair shall be reserved, considering the dimensions of the components or units.

The system shall be clean and equipped with clean filters at handing over.

NOTE Further guidance is given in FprCEN/TR 16798-4.

8.12 Process from project initiation to operation

The process from the initiation of the project to the normal operation is generally characterised by the following steps. Nevertheless the definitive organisation is always in accordance with the specific contract.

NOTE More details are given in FprCEN/TR 16798-4 in the form of checklists.

The process shall be specified considering the following points.

a) Project initiation;

b) Definition of design conditions and requirements (design documents);

c) Check with authorities, relevant regulations;

d) Design;

e) Installation;

f) Check of the installation;

g) Start of operation, check of functions, balancing, testing with written records and if agreed measurements according to EN 12599;

h) Start of operation;

i) Declaration of finished installation, addressed to the client;

j) Completeness check, functional tests, functional measurements and special measurements according to EN 12599;

k) Hand over the system including the delivery of all relevant documents with instructions how to operate and maintain the system, to the client;

l) Operation and maintenance;

m) Regular system inspections, e.g. energy inspections (see M4-11, M5-11; M6-11, M7-11);

n) Monitoring the energy consumption by bookkeeping or another way of recording.

8.13 Supply air humidity

Supply air humidity shall be controlled so that no condensation takes place on the interior surfaces of ductwork or on the interior surfaces of the building envelope. Surface condensation increases always risk of microbial growth and shall be avoided.

Design of the supply air flow and humidity shall be based on the sources of humidity from indoor and outdoor. Indoor sources include humidity from human occupancy, plants, pools etc. outdoor source (or sink) of humidity is infiltration of outdoor air through the building envelope and openings.

Pressure differences over the building envelope may drive the humid indoor air into the structure or building component (exfiltration) and cause condensation in the structure. Condensation in the building structure damages the building materials and increases the risk of microbial growth. High indoor humidity and low outdoor temperature increases the risk of condensation.

The airtightness design of the building envelope is the main limitation of avoiding of exfiltration through the building structure. The air balance of the supply and exhaust (and extract) air flows shall be arranged to reduce exfiltration of humid air to an amount, that the risk of condensation in the structure is negligible.

Humidification or dehumidification of room air with supply air is usually not required but if they are used, the use shall be designed for the limits of the allowed humidity range, the minimum for humidification and the maximum for dehumidification.

NOTE M1-6 gives more guidance on target values for humidification and dehumidification.

9 Classification

9.1 Specification of types of air

The types of air in a building and in a ventilation or air-conditioning system are specified in Table 6 and illustrated in Figure 2. The abbreviations and colours given in Table 6 shall be used to mark the type of air in drawings of ventilation or air-conditioning systems. The abbreviations can also be helpful for the labelling of system parts.

Table 6 — Specification of types of air

No. (in Figure 2)	Type of air	Abbreviation	Colour	Definition
1	Outdoor air	ODA	Green	Air entering the system or opening from outdoors before any air treatment
2	Supply air	SUP	Blue	Airflow entering the treated room, or air entering the system after any treatment
3	Indoor air	IDA	Grey	Air in the treated room or zone
4	Transferred air	TRA	Grey	Indoor air which passes from the treated room to another treated room
5	Extract air	ETA	Yellow	The airflow leaving the treated room and entering the air treatment system.
6	Recirculation air	RCA	Orange	Extract air that is returned to the air treatment system and reused as supply air
7	Exhaust air	EHA	Brown	Airflow leaving the extract air treatment system and discharged to the atmosphere.
8	Secondary air	SEC	Orange	Airflow taken from a room and returned to the same room after any treatment. NOTE Induced air in an induction unit is considered as secondary air.
9	Leakage	LEA	Grey	Unintended airflow through leakage paths in the system
10	Infiltration	INF	Green	Leakage of air into building through leakage paths in elements of structure, unintended air from outdoor
11	Exfiltration	EXF	Grey	Leakage of air out of building through leakage paths in elements of structure, unintended to outdoor air
12	Mixed air	MIA	Streams with separate colours	Air which contains two or more streams of air
1.1	Single room outdoor air	SRO	Green	Air entering the single room air handling unit or opening from outdoors before any air treatment
2.1	Single room supply air	SRS	Blue	Airflow entering the treated room
5.1	Single room extract air	SET	Yellow	The airflow leaving the treated room into a single room air handling unit
7.1	Single room exhaust air	SEH	Brown	Airflow discharged to the atmosphere from a single room air handling unit.

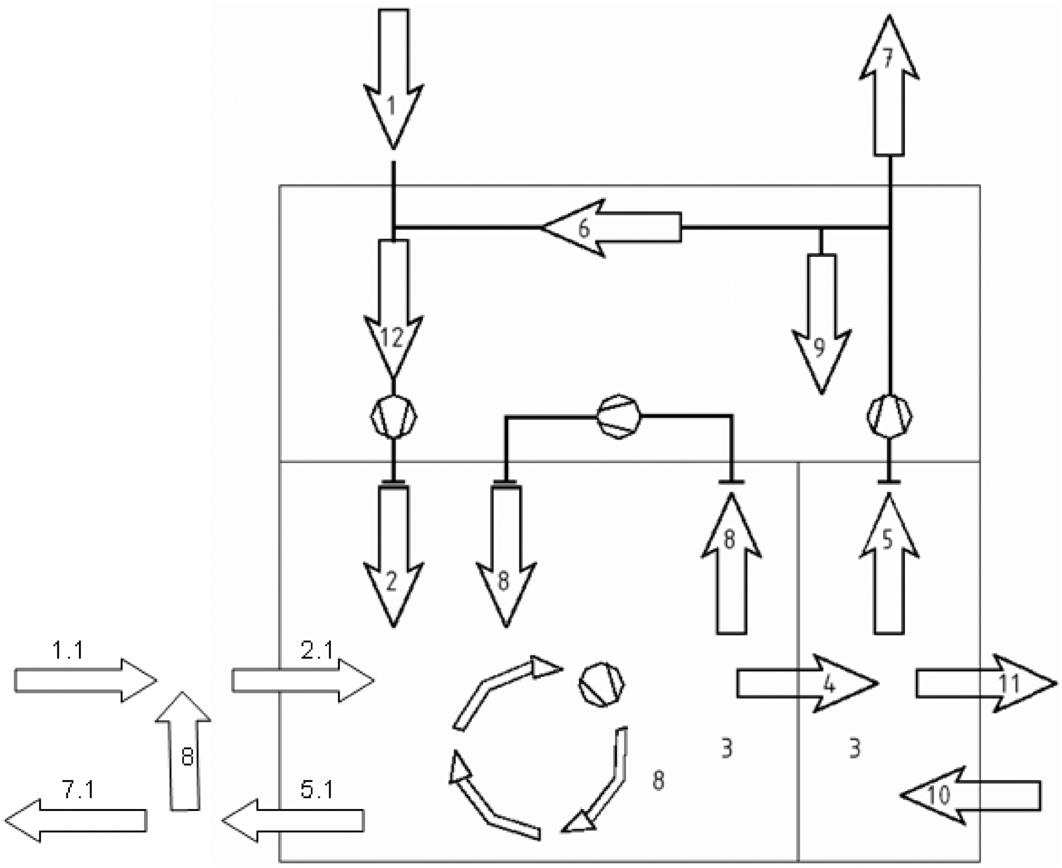


Figure 2 — Illustration of types of air using numbers given in Table 7

9.2 Classification of air

9.2.1 Extract air and exhaust air

The classifications of extract air and exhaust air for the application in this standard are given in Table 7. In case the extract air contains different categories of extract air from different rooms, the stream with the highest category-number determines as a default the category of the total air stream.

NOTE For mixed air flow classification see FprCEN/TR 16798-4.

The categories for exhaust air apply to the air after any cleaning that is used. When exhaust air is cleaned, the method and the expected effect of the cleaning shall be stated clearly and evidence shall be provided of the initial and continuing effectiveness of the cleaning process. The cost-effectiveness shall also be considered, especially if the aim is to improve the exhaust air by more than one class. Exhaust air of class EHA 1 cannot be achieved by cleaning.

Table 7 — Classification of extract air (ETA, SET) and exhaust air (EHA, SEH)

Category	Description
ETA 1, SET1 EHA 1, SEH 1	Air with low pollution level Air from rooms where the main emission sources are the building materials and structures, and air from occupied rooms, where the main emission sources are human metabolism and building materials and structures. Rooms where smoking is allowed are excluded.
ETA 2, SET 2 EHA 2, SEH 2	Air with moderate pollution level Air from occupied rooms, which contains more impurities than category 1 from the same sources and/or also from human activities.
ETA 3, SET 3 EHA 3, SEH 3	Air with high pollution level Air from rooms where emitted moisture, processes, chemicals, tobacco smoke etc. substantially reduce the quality of the air.
ETA 4, SET 4 EHA 4, SEH 4	Air with very high pollution level Air which contains odours and impurities in significantly higher concentrations than those allowed for indoor air in occupied zones.

9.2.2 Outdoor air

In the process of system design, consideration needs to be given to the quality of the outdoor air around the building or proposed location of the building. In the design, there are two main options for mitigating the effects of poor outdoor air on the indoor environment:

— locate air intakes where the outdoor air is least polluted (if the outdoor air pollution is not uniform around the building);

— apply some form of filtration and/or air cleaning.

Design shall take into account:

— what local regulations are in force;

— choices to adopt regulations and guidelines;

— individual choices about the importance of specific pollutants (e.g. particles, gases, pollens, fungal spores of outdoor origin).

NOTE See FprCEN/TR 16798-4 for further information about these options.

The outdoor air classification is given in Table 8. These categories shall be used to inform all involved parties on the outdoor pollution and in combination with the supply air classification Table 9 about the required filtration (Table 16) and air cleaning (Table 17).

Table 8 — Classification of outdoor air (ODA)

Category	Description
ODA 1	Outdoor air which may be only temporarily dusty (e.g. pollen)
ODA 2	Outdoor air with high concentrations of particulate matter and/or gaseous pollutants
ODA 3	Outdoor air with very high concentrations of gaseous pollutants and/or particulate matter

The classification according to Table 8 shall be performed separately for gaseous ODA (G) and particle ODA (P) pollutants.

Application of such a classification depend on defining the criteria, see A.4.3 or B.4.3.

9.2.3 Supply air

The quality of the supply air for buildings subject to human occupancy shall consider the expected emissions from indoor sources (human metabolism, activities and processes, building materials, furniture) and from the ventilation system itself to ensure that proper indoor air quality shall be achieved.

NOTE prEN 16798-1:2015 gives more guidance on the use of "low polluting materials" or "low polluting buildings".

The outdoor air rates shall be specified in design of the system. If supply air also contains recirculation air, this shall be noted in design documentation, too. Only extract air of category ETA1 can be recirculated to the other rooms. Extract air of category ETA2 can be recirculated to the same room.

Supply air category shall be specified by using Table 9.

Table 9 — Classification of supply air

Category	Description
SUP 1	Supply air with very low concentration of particulate matter and/or gases
SUP 2	Supply air with low concentrations of particulate matter and/or gases
SUP 3	Supply air with medium concentrations of particulate matter and/or gases matter
SUP 4	Supply air with high concentrations of particulate matter and/or gases matter
SUP 5	Supply air with very high concentrations of particulate matter and/or gases matter

Application of such a classification depend on defining the criteria according to Annex B.

9.2.4 Indoor air

The aspects of indoor air quality in relation to the persons are given in M1-6 on the bases of a fully mixed air (assuming a ventilation effectiveness of 1).

9.2.5 Exhaust air

Exhaust air shall be discharged from the building so that air does not re-enter in the building or enter to the adjacent buildings or cause harmful effects to the occupants close to the building (walkways, terraces etc). Exhaust air of category EHA 4 shall be lead to roof of the building.

9.3 System functions and basic system types

9.3.1 General

Ventilation, air-conditioning and room-conditioning systems are intended to control the indoor air quality and the thermal and humidity conditions in the room to a specification that is agreed in advance. The indoor air quality shall be chosen by the user demand, the space requirements for the system and the life cycle costs. Therefore a solution shall be found which is well suited to the actual requirements.

Ventilation systems consist of a supply and an extract air system and usually they are equipped with filters for the outdoor air, and possibly heat recovery devices and heating/cooling devices. Extract air systems with no supply air system might not fulfil all the selected requirements. Supply air systems with no extract air system do not generally allow heat recovery and lead to an overpressure which may be in some cases hazardous to the building fabric.

In a balanced mechanical ventilation system with supply and extract air the extract airflow rate is given by the supply airflow rate and the air balance class (9.4) needed.

9.3.2 Types and configurations

Air-conditioning and room conditioning systems may or may not be combined with ventilation systems. Table 10 shows the principle ventilation systems based on the air volume flow.

Table 10 — Basic system types of ventilation systems

Description	Name of the system type
Ventilation system with a fan assisted air volume flow in only one direction (either supply or exhaust) which is balanced by air transfer devices in the building envelope.	Unidirectional ventilation system (UVU)
Ventilation system with a fan assisted air volume flow in both direction (supply and exhaust)	Bidirectional ventilation system (BVU)
Ventilation relying on utilisation of natural driving forces[13)]	Natural ventilation system
Ventilation relying to both natural and mechanical ventilation in the same part of a building, subject to control selecting the ventilation principle appropriate for the given situation (either natural or mechanical driving forces or a combination thereof).	Hybrid ventilation system

13) Further guidance is given in FprCEN/TR 16798-4.

Based on ventilation and thermal functions, a ventilation or air-conditioning system can be specified by functions as shown in Table 11. Systems may also be combined to provide more functions.

Table 11 — Types of Ventilation-, Air-conditioning-, and Room Conditioning-Systems based on functions

System	Supply Air Fan	Extract Air Fan	Secondary Fan	Heat Recovery	Waste heat pump	Filtration	Heating	Cooling	Humidification	Dehumidification
Unidirectional supply air ventilation system (Positive pressure ventilation)	x	-	-	-		o	o	-	-	-
Unidirectional exhaust air ventilation system	-	x	-		o	-	-	-	-	-
Bidirectional ventilation system	x	x	-	x	o	x	o	-	-	-
Bidirectional ventilation system with humidification	x	x		x	o	x	o	-	x	-
Bidirectional air-conditioning system	x	x		x	o	x	o	(x)	o	(x)
Full air-conditioning system	x	x		x	o	x	x	x	x	x
Room air conditioning system (Fan-Coil, DX-Split- Systems, VRF, local water loop heat pumps, etc.)	-	-	x	-	-	o	o	x	-	(x)
Room air heating systems	-	-	x	-	-	o	x	-	-	-
Room conditioning system	-	-	-	-	-	-	o	x	-	-

x equipped with.

(x) equipped with, but function might be limited.

\- not equipped with.

o may or may not be equipped with depending on requirements.

Cooling means any component in the unit or the room lowering the supply air or room air enthalpy (for example cooling coil with chilled water, cooling water or ground source water or brine).

9.3.3 Controls and operation

The basic categories of the system type are dependent on its capability for controlling the indoor air quality and the means and degree of control of the thermodynamic properties in the room. The category and type of control, and parameters to be controlled shall be specified.

For control of the indoor air quality, possible categories are given in Table 12.

NOTE Possibilities to reduce the energy consumption by Demand Controlled Ventilation are introduced in FprCEN/TR 16798-4.

Table 12 — Possible types of control of the air flow rate

Category	Description
IDA – C 1	The system runs constantly.
IDA – C 2	Manual control The system runs according to a manually controlled switch.
IDA – C 3	Time control The system runs staged according to a given time schedule.
IDA – C4	Presence control The system runs dependent on the presence (light switch, infrared sensors etc.)
IDA – C5	Demand control (based on the number of occupants) The system runs staged dependent on the number of people in the space.
IDA – C 6	Demand control (based on air quality indicator) The system is controlled by sensors measuring indoor air parameters or adapted criteria, which shall be specified (e.g. CO_2, mixed gas, humidity or VOC sensors). The used parameters shall be adapted to the kind of activity in the space.

The type of control shall be specified either

— Individual per each room (R),

— Centralised per each zone (Z)

NOTE For example IDA-C4 (R) for occupancy control in the room or IDA-C4 (Z) in a zone.

The type of the fan speed control shall be specified:

— Variable speed drive (for example: inverter, EC-motor) (F)

— Multi speed drive (for example: 2/3 speed motor, transformer) (M)

— On/off controlled. (O)

EXAMPLE IDA-C4 (R-M) for occupancy control in the room and variable speed drive or IDA-C4 (Z-M) in a zone with multi speed drive.

Whichever control system is used (including manual control), better performance can generally be achieved by using some form of predictive control considering expected parameters. Time shall be considered in the control strategy. Classes IDA-C5 and C6 are associated with a regulation of airflows. If the range of variation of airflows can induce large fluctuation of pressure, a system of control on pressure should be used or any airflow regulation to take it into account.

For details on control options see M10.

9.4 Design air flow balance

In order to control the flow direction and the distribution of emissions between areas of the building and/or with the outside, pressure conditions are created by means of different supply and extract airflows. The pressure conditions in the areas can be designed and controlled by ventilation air flows. Possible categories for design air flow balance conditions are as given in Table 13.

Table 13 — Categories of design air flow balance in the area

Category	Description (situation with no wind and no stack effect)
AB 1	$q_{exhaust} > 1,15\ q_{supply}$
AB 2	$1,05\ q_{supply} < q_{exhaust} < 1,15\ q_{supply}$
AB 3	$0,95\ q_{supply} < q_{exhaust} < 1,05\ q_{supply}$
AB 4	$0,85\ q_{supply} < q_{exhaust} < 0,95\ q_{supply}$
AB 5	$q_{exhaust} < 0,85\ q_{supply}$

The choice of air flow balance level depends on the specific application. In some cases more than one level of under- or overpressure is required to control the airflow between all areas of the building. In addition to flow direction requirements, also other aspects may have to be taken into account.

9.5 Specific fan power

9.5.1 General

The specific fan power is a simple value to determine the efficiency of the air transportation in a given system. There are several ways to calculate depending on the individual needs of the system or product.

Generally the specific fan power is defined as:

$$P_{SFP} = \frac{P}{q_v} = \frac{\Delta p_{tot}}{\eta_{tot}} = \frac{\Delta p_{stat}}{\eta_{stat}} \quad (1)$$

where

P_{SFP} is the specific fan power in W.m^{-3}.s

P is the input power of the motor for the fan in W

q_v is the design air-volume-flow through the fan in m^3.s^{-1}

Δp_{tot} is the total pressure difference across the fan

η_{tot} is the overall efficiency of the fan based on total pressure

Δp_{stat} is the static pressure difference across the fan

η_{stat} is the overall efficiency of the fan based on static pressure

The coefficient is related to an air density of 1,2 kg.m^{-3}.

9.5.2 Classification of specific fan power

9.5.2.1 General

The classification of the specific fan power (for each fan unit or building) is given in Table 14. The specific fan power shall be specified at the design condition.

Table 14 — Classification of specific fan power

Category	P_{SFP} in (W/(m³ /s)
SFP 0	< 300
SFP 1	≤ 500
SFP 2	≤ 750
SFP 3	≤1 250
SFP 4	≤2 000
SFP 5	≤ 3 000
SFP 6	≤ 4 500
SFP 7	> 4 500

The specific fan power P_{SFP} depends on the pressure drop, the efficiency of the fan and the design of the motor and the drive system.

9.5.2.2 Extended specific fan power

Classification in Table 14 is for standard application. Table 15 gives values for extended PSFP for special applications. Additional pressure losses of special components can increase the specific fan power. The values in Table 15 shall be added to the values in Table 14 to shift the limits of each SFP category.

Example

Category SFP 3: P_{SFP} = 750 – 1 250 W/m³/s

Additional filter stage: extended P_{SFP} = 300 W/m³/s

Total: P_{SFP} = 1 050 – 1 550 W/m³/s

Table 15 — Extended P_{SFP} for additional components

Component	P_{SFP} in (W/(m³ /s)
Additional mechanical filter stage[a]	+ 300
HEPA Filter according to EN 1822-3	+ 1 000
Gas Filter	+ 300
Heat recovery class H2 or H1[b]	+ 300

[a] a second filter (first filter min. F7 for supply or M5 for exhaust) is the additional filter stage.

[b] Class H2 or H1 according to EN 13053:2006+A1:2011.

9.5.3 Calculating the power demand of the fan

The useful power supplied from the mains to each individual fan can be expressed as follows:

$$P_{mains} = \frac{q_V \cdot \Delta p_{tot}}{\eta_{tot}} = \frac{q_V \cdot \Delta p_{stat}}{\eta_{stat}} \qquad (2)$$

where

P_{mains} is useful power supplied from the mains in W

q_V is the air volume flow through the fan in m³ x s⁻¹

Δp_{tot} is total pressure rise from the fan inlet to the outlet in Pa

Δp_{stat} is static pressure rise from the fan inlet to the outlet in Pa

η_{tot} is $\eta_{fan\ tot}$ x η_{tr} x η_m x $\eta_{c\ based}$ on total pressure

η_{stat} is $\eta_{fan\ stat}$ x η_{tr} x η_m x $\eta_{c\ based}$ on static pressure

$\eta_{fan\ tot}$ is efficiency of the fan including bearing losses based on total pressure

$\eta_{fan\ stat}$ is efficiency of the fan including bearing losses based on static pressure

η_{tr} is efficiency of the mechanical transmission

η_m is efficiency of the electric motor excluding any control

η_c is efficiency of the control equipment including its effect on motor losses

Fan system efficiency

The overall efficiency η_{fan} is based on the efficiencies of the single components (impeller, motor, belt drive, speed control, etc.)

$$\eta_{fan} = \eta_{impeller} \cdot \eta_{motor} \cdot \eta_{drive} \cdot \eta_{control} \qquad (3)$$

$\eta_{impeller}$ impeller efficiency

η_{Motor} Motor efficiency

η_{Drive} Drive efficiency e. g. belt drive

$\eta_{Control}$ Speed control efficiency e. g. frequency inverter

NOTE 1 The system efficiency and influencing factors are explained in more detail in supplementing FprCEN/TR 16798-4.

NOTE 2 Fans driven by motors with electric input power between 125 W and 500 kW need to comply with Ecodesign Regulation EU 327/2011. Details about fan efficiency are specified in EN ISO 12759. See also CEN mandate 500 ongoing works.

9.5.4 Specific Fan Power of an entire building

The $P_{SFP,B}$ is defined as follows: "The amount of electric power consumed by all the fans in the air distribution system divided by the total airflow rate through the building under design load conditions, in [kW/(m3/s)]".

$$P_{SFP,B} = \frac{P_{mains,SUP} + P_{mains,ETA}}{q_{V,\max}} \qquad (4)$$

where

$P_{SFP,B}$ is specific fan power demand of the entire building in W x m^{-3} x s

$P_{mains.SUP}$ is the total fan power of the supply air fans at the design air flow rate in W

$P_{mains,ETA}$ is the total fan power of the extract air fans at the design air flow rate in W

$q_{V;max}$ is the design extract air volume flow through the building in m^3 x s^{-1}

In terms of P_{SFP} for the whole building, any fan powered terminals shall be included when they are connected to the main air supply system.

9.5.5 Specific fan power under reference conditions is P_{SFP} and under design load conditions is P_{SFPd}.Specific Fan Power of Individual Air Handling Units

To enable the designers of building projects to quickly determine whether a given air handling unit will positively or negatively meet the overall demands on power efficiency, a $P_{SFP,E}$ for the individual air handling unit is defined. In some cases specific demands on power efficiency for each individual fan/air handling unit might have been stated in the project specification according to (5).

$$P_{\text{SFP, E}} = \frac{P_{main,SUP}}{q_{\text{v,SUP}}} + \frac{P_{main,ETA}}{q_{\text{v,ETA}}} \quad (5)$$

NOTE In case of disbalance, sometimes the maximum is used to calculate $P_{\text{SFP, E}}$.

where

$P_{\text{SFP,E}}$	is specific fan power demand of the ventilation unit calculated with the individual air volume flows in W x m^{-3} x s
$P_{\text{mains.SUP}}$	is the total fan power of supply air fans in the unit at the design air flow rate in W
$P_{\text{mains,ETA}}$	is the total fan power of extract air fans in the unit at the design air flow rate in W
$q_{\text{v;SUP}}$	is the design supply air volume flow of the unit in m^3 x s^{-1}
$q_{\text{v;ETA}}$	is the design extract air volume flow of the unit in m^3 x s^{-1}

9.5.6 AHU related P_{SFP} values

To enable the designers of building projects to quickly determine whether a given air handling unit will positively or negatively meet the unit related demands on power efficiency, a $P_{\text{SFP,int}}$ and $P_{\text{SFP,add}}$ for the individual air handling unit has been defined. In this case the 3 parts of P_{SFP} (internal, additional and external pressure loads) are defined separately.

NOTE Requirements on ventilation units are specified in ErP Regulation EU 1253/2014 and EN 13053.

The **internal specific fan power** $P_{\text{SFP,int}}$ is the electric power, in kW, supplied to a fan and related to the internal pressure of all ventilation components (Filters, heat recovery and related casing) divided by the air flow expressed in m^3/s under design load conditions.

EN 13053 is specifying details how $P_{\text{SFP,int}}$ shall be determined for a units.

The **additional specific fan power** $P_{\text{SFP,add}}$ is the electric power, in kW, supplied to a fan and related to the internal pressure of all internal additional ventilation components (coolers, heaters, humidifier, etc.) divided by the air flow expressed in m^3/s under design load conditions.

The **external specific fan power** $P_{\text{SFP,ex}}$ is the electric power, in kW, supplied to a fan and related to the external pressure divided by the air flow expressed in m^3/s under design load conditions.

$$P_{\text{SFP, SUP}} = P_{SFP,\ SUP,\ int} + P_{SFP,\ SUP,\ add} + P_{SFP,SUP,\ ext} \quad (6)$$

$$P_{\text{SFP, EXT}} = P_{SFP,\ EXT,\ int} + P_{SFP,\ EXT,\ add} + P_{SFP,EXT,\ ext} \quad (7)$$

$$P_{\text{SFP}} = \frac{\Delta p_{\text{int tot}}}{\eta_{\text{tot}}} + \frac{\Delta p_{\text{add tot}}}{\eta_{\text{tot}}} + \frac{\Delta p_{\text{ext tot}}}{\eta_{\text{tot}}} = \frac{\Delta p_{\text{int stat}}}{\eta_{\text{stat}}} + \frac{\Delta p_{\text{add stat}}}{\eta_{\text{stat}}} + \frac{\Delta p_{\text{ext stat}}}{\eta_{\text{stat}}} \quad (8)$$

$$P_{\text{SFP,int}} = P_{\text{SFP, SUP, int}} + P_{\text{SFP, EXT, ,int}} \quad (9)$$

where

$\Delta p_{\text{int tot}}$	is total internal pressure drop from the ventilation components (fan casing, heat recovery, and filters) in Pa

$\Delta p_{\text{add tot}}$	is total additional pressure drop from the additional components (cooler, heat exchanger, humidifier, silencer, etc.) in Pa
$\Delta p_{\text{ext tot}}$	is total external pressure drop from the ductwork and external components in Pa
$\Delta p_{\text{int stat}}$	is static internal pressure drop from the ventilation components (fan casing, heat recovery and filters) in Pa
$\Delta p_{\text{add stat}}$	is static additional pressure drop from the additional components (cooler, heat exchanger, humidifier, silencer, etc.) in Pa
$\Delta p_{\text{ext stat}}$	is static external pressure drop from the ductwork and external components in Pa
η_{tot}	is $\eta_{\text{fan tot}}$ x η_{tr} x η_{m} x η_{c} based on total pressure
η_{stat}	is $\eta_{\text{fan stat}}$ x η_{tr} x η_{m} x η_{c} based on static pressure
$P_{SFP,\ SUP}$	is the SFP-value on supply air side
$P_{\text{SFP, EXT}}$	is the SFP value on extract air side
$P_{\text{SFP,int}}$	is the internal SFP value of the bidirectional air handling unit.

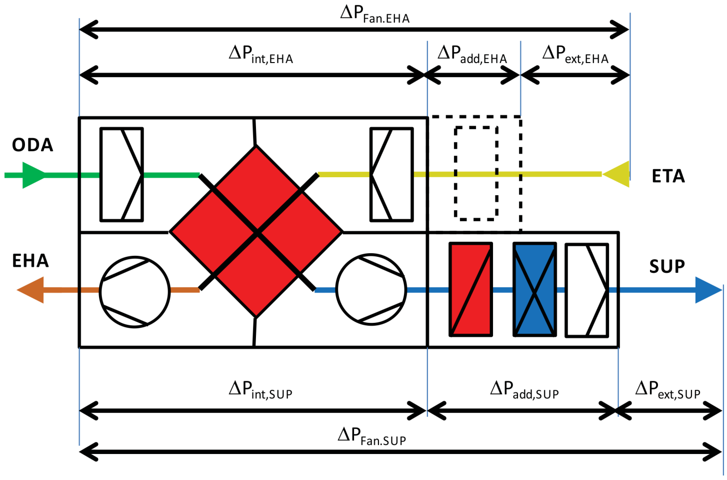


Figure 3 — AHU related P_{SFP} values

9.6 Heat recovery section

9.6.1 General

The recovery of heat and cold from extract air is a very efficient energy saving method. It is mandatory in air treatment devices with the use of fresh air and extract air (BVU).

The use of an indirect evaporative cooling, humidity recovery, the use of a heat pump or the coupling and decoupling energy flows from other processes (e.g. free cooling, waste heat) shall be considered.

9.6.2 Requirements for heat recovery

The quality of a heat recovery is determined on the basis of the temperature ratio Φ_t (temperature efficiency) and the electric power consumption (based on pressure losses and auxiliary consumers e.g. pumps).

The temperature ratio Φ_t indicates the ratio between the temperature change of the outdoor air of a heat recovery and the maximum possible temperature change, the difference between the outdoor air and the exhaust air temperatures at balanced mass flow:

$$\Phi_t = (\theta_{22} - \theta_{21}) / (\theta_{11} - \theta_{21}) \tag{10}$$

where

φ_t temperature efficiency at balanced mass flows

θ_{22} outlet temperature HRS cold air stream

θ_{21} inlet temperature HRS cold air stream

θ_{11} inlet temperature HRS warm air stream

The temperature ratio in EN 13053 is defined under “dry conditions” and balanced mass flow, i.e., without condensation (nominal operation point). EN 308 and EN 13053 shall be used to specify the performance characteristics of heat recovery systems.

The selection of the heat recovery (thermal efficiency and pressure losses) should be based on economic calculations. The verification of performance data on site is very difficult, therefore reliable performance data shall be used.

The heat recovery shall be controlled to avoid overheating of supply air during the warm weather conditions when the recovered heat cannot be used feasibly.

In case of location of the heat recovery unit in the conditioned space, the heat loss of the connection pipes to the outdoor environment shall be considered in energy calculation.

NOTE Further guidance is given in FprCEN/TR 16798-4.

9.6.3 Transfer of humidity

The option of humidity transfer in heat recovery system shall be checked based on possible technology, space and application

NOTE See FprCEN/TR 16798-4.

9.6.4 Icing and defrosting

Depending on the selected heat recovery system and the operation conditions, the aspects of icing and defrosting shall be considered.

NOTE Further guidance in given in FprCEN/TR 16798-4.

9.6.5 Transfer of pollutants

Regenerative heat exchangers should not be used in buildings parts with very delicate occupants in operation theatre, intensive care, infection wards in hospitals.

The leakage to supply air in the heat recovery unit and its heat exchanger shall be classified according to 9.8. To avoid potential hazards the pressure of outdoor air side shall be higher than exhaust air side when the category of exhaust air is ETA 3 or 4 or when the ETA category of exhaust air is higher than in the rooms which supply air from the unit is serving.

9.7 Filtration

9.7.1 General aspects

The filtering of outdoor air shall be chosen to meet the requirements of the indoor air in the building taking into consideration the category of outdoor air (Table 16 and Table 17). The dimensioning of filter sections should be the result of an optimisation, taking into account the specific situation (running time, dust load, special local pollution situation, etc.).

Depending on outdoor particle pollution level and desired supply air quality different levels of filtration are required.

The required filtration efficiency can be achieved by using single or multiple stage filtration. It is the combined filtration efficiency of the entire filtration stage that determines if required supply air quality is achieved.

To maintain a good sanitary level in the ventilation system the minimum combined filtration efficiency is specified in A.4.2 and B.4.2 in accordance with EN 779.

In cases where supply air level of SUP 1 or 2 is required and where the outdoor air quality based on gaseous components is of level ODA 2 or ODA 3 it is recommended to complete the particle filtration with suitable gas phase filtration (Table 17) to reduce harmful levels of CO, NOx, SOx, VOC and O_3.

The below Table 16 shows the required combined average filtration efficiency (EN 779) needed to go from an ODA level to a desired SUP level:

Table 16 —Minimum filtration efficiency based on particle outdoor air quality

Outdoor air quality	Supply air class				
	SUP 1	SUP 2	SUP 3	SUP 4	SUP 5
ODA (P) 1	88 %[a]	80 % [a]	80 % [a]	80 % [a]	Not specified
ODA (P) 2	96 % [a]	88 % [a]	80 % [a]	80 % [a]	60 %
ODA (P) 3	99 % [a]	96 % [a]	92 % [a]	80 % [a]	80 %

[a] Combined average filtration efficiency over a single or multiple stage filtration in accordance to average filtration efficiency specified in EN 779.

The combined filtration efficiency shall be calculated according to (11):

$$E_t = 100 * \left(1 - \left(\left(1 - \frac{E_{s1}}{100} \right) * \left(1 - \frac{E_{s2}}{100} \right) * \ldots \ * \left(1 - \frac{E_{sn+1}}{100} \right) \right) \right) \quad (11)$$

where

E_t is the total filter efficiency

E_{sn+1} is the efficiency of each filter step

Default filter classes are given in Annex A or Annex B.

In case of optional gas filtration, the main pollutants according to the classification of the actual outdoor and selected supply air shall be identified and being considered to design gas filtration by Table 17.

Table 17 —Application of gas filter as complement to particle filtration based on gaseous outdoor air quality

Outdoor air quality					
	SUP 1	SUP 2	SUP 3	SUP 4	SUP 5
ODA (G)1	recommended				
ODA (G) 2	required	recommended			
ODA (G)3	required	required	recommended		
G = Gas filtration; should be considered if design SUP quality category is above design ODA quality category. Dimensioning should be done in accordance with EN ISO 10121-1 and EN ISO 10121-2.					

NOTE Further consideration on gas filtration is given in FprCEN/TR 16798-4.

Special attention to airtightness of both the building envelope and air handling units (see EN 1886 for filter bypass leakage) shall be paid, especially if filters of class F7 or higher are used. In situations with one filter step and the fan is belt driven, the filter shall be placed after the fan. With two or more filter steps, the first filter section shall be placed before, the second filter section after the air treatment.

Care shall be taken to protect the ventilation unit and the ventilation equipment from dust of the outdoor air. This can be done with a filter stage at the inlet of the ventilation unit and this can also extend the time for changing the second filter.

Special attention should be paid to the influence of pressure conditions to the air flows, influencing the electrical energy consumption. To avoid increasing the installation running costs, designers shall select air filters upon the assessment of total energy consumption during the operation time, using life cycle costing methodology.

Optional gas filters shall generally be combined with filters F8 or F9 downstream.

It is important to protect the filters from getting wet; the relative humidity over a long period should be less than 80 %.

In category ODA 3 (highly industrialised regions, near airports etc.) electrostatic filtering can be needed in some applications. In case of temporarily polluted outdoor air, it is recommended to equip these filters with a bypass (equipped with gastight dampers), and provide continuous monitoring of air quality.

9.7.2 Filter maintenance

A plan for regular filter changing is needed, see EN 15780. Changing of filter shall be primarily based on dust accumulated in the filter. The need of filter change depends of the lifetime and the state (pressure drop, damages, contamination). The manufacturer defines the final pressure drop. The entire state of the filter can only evaluated visually.

Filter may be also a source of pollution like odour and may need to be changed more often than visual inspection or pressure drop indicates.

The relative humidity in the air of filters shall be limited to 90 %, see EN 13053. The outdoor intake should be constructed so that the rain or snow cannot enter to the system.

9.8 Leakages in ventilation systems

9.8.1 General

Leakages of the air distribution or the AHU casing impact energy efficiency and function, as well hygiene aspects (e.g. condensation). It is important to minimize leakages.

There are three different leakages which shall be considered:

— leakages in heat recovery section – internal leakages

— leakages of the AHU casing – external leakages

— leakages of the air distribution (ducts) including components

The leakages shall be avoided. The remaining leakages shall be classified (see 9.8.6.2, Table 19 and EN 1886) and compensated so, that the nominal amount of airflow is supplied and extracted in the occupied zone.

9.8.2 Leakages in heat recovery section

Leakages of heat recovery are defined by the following two numbers.

Exhaust Air Transfer ratio (EATR) [%]:

Transfer of extract air into the supply air side. EATR provides information on the level of carry over of the supply air by the extract air in the heat recovery component.

$$EATR = \frac{q_{m,SUP} - q_{m,SUPnet}}{q_{m,SUP}} = 1 - \frac{q_{m,SUPnet}}{q_{m,SUP}} \quad (12)$$

where

$q_{m,SUP,HR}$ is the air mass flow of supply air leaving the HR component

$q_{m,SUPnet,HR}$ is the air mass flow of supply air leaving the HR component which originates from the outdoor air entering the HR component

NOTE Further specification on EATR will be made in the EN 308 revision.

Outdoor Air Correction Factor (OACF) [-]:

Ratio of the entering supply mass airflow rate and the leaving supply mass airflow rate:

$$OACF = \frac{q_{m,ODA,HR}}{q_{m,SUP,HR}} \quad (13)$$

where

$q_{m,ODA,HR}$ is the air mass flow of outdoor air entering heat recovery component

$q_{m,SUP,HR}$ is the air mass flow of supply air leaving the heat recovery component

If OACF>1: air is transferred from outdoor air to extract air

If OACF<1: air is transferred from extract air to supply air (air recirculation)

NOTE Further specification on OACF will be made in EN 308 revision.

With these two values the leakage situation is defined. EATR and OACF shall be calculated by the heat recovery manufacturer for the nominal design condition of the air handling unit.

9.8.3 Classification of outdoor air correction factor at heat recovery systems

The outdoor air correction factor at nominal conditions and nominal air volume flow of the heat recovery section shall be classified according to Table 18.

Table 18 — Classification of outdoor air correction factor

	OACF	
Class	Outdoor to exhaust air	Extract to supply air
1	1,03	0,97
2	1,05	0,95
3	1,07	0,93
4	1,10	0,9
5	Not classified	

9.8.4 Leakages at Air Handling unit (AHU) casing

Requirements and classification of leakages of the AHU casing shall be considered separately for negative pressure and positive pressure referred to EN 1886. If nothing is defined, the value of the casing leakage is defined based on the filter classes of AHU. If a multilevel filtration is used, the filter class of the most high quality filter is taken.

The minimum leakage class is specified in A.4.4 or B.4.4.

9.8.5 Filter by-pass leakages

Requirements and classification of filter bypass leakages shall be according to EN 1886. If nothing is defined, the value of the filter by-pass leakage is defined based on the filter classes of AHU (see chapter 8 and Table 16 regarding the filtration requirements). If a multilevel filtration is used, the filter class of the most high quality filter is taken.

9.8.6 Leakages of air distribution systems

9.8.6.1 General

The leakages of air distribution systems shall be classified according to Table 19.

Testing of installed systems in situ is described in EN 12599.

NOTE The testing of ductwork and components is listed in the product standards. The classification and testing of airtightness of round ducts are defined in EN 12237, of rectangular ducts in EN 1507, of flexible ducts in EN 13180, of dampers and valves in EN 1751, of non-metallic ducts made from insulation ductboards in EN 13403, of non-metallic ducts made from plastics or composites predominantly made from plastics WI 00156179, of other components in EN 15727.

The minimum requirements shall be specified according to Table 19. Default values are given in A.4.5 or B.4.5.

9.8.6.2 Classification of duct Leakage

The leakage class of the duct system shall be classified according to Table 19. The leakage class shall be verified according to EN 12599. In large systems and systems in which all components are tested and classified, testing only parts of the system is sufficient according to EN 12599.

Table 19 — Classification of system air tightness class

Air tightness class		Air leakage limit (f_{max}) $m^3\ s^{-1} \cdot m^{-2}$
Old	**New**	
	ATC 7	not classified
	ATC 6	$0{,}0675 \times p_t^{0,65} \times 10^{-3}$
A	ATC 5	$0{,}027 \times p_t^{0,65} \times 10^{-3}$
B	ATC 4	$0{,}009 \times p_t^{0,65} \times 10^{-3}$
C	ATC 3	$0{,}003 \times p_t^{0,65} \times 10^{-3}$
D	ATC 2	$0{,}001 \times p_t^{0,65} \times 10^{-3}$
	ATC 1	$0{,}00033 \times p_t^{0,65} \times 10^{-3}$

NOTE If no leakage is measured the default value for calculation will be $0{,}0675 \times p_t^{0,65} \times 10^{-3}$.

10 Calculation and energy rating

10.1 Ventilation effectiveness and air diffusion

10.1.1 General

There is a relationship between efficiency of ventilation defined with contaminant concentration and the air diffusion chosen. Yet, this relation depends on a significant amount of parameters, including source distribution, design rules, building loads and sizing of equipment.

10.1.2 Calculation of ventilation air volume flow

The ventilation rates specified in M1-6 are the required rates at breathing level in the occupied zone based on ventilation effectiveness ε_V=1. The required ventilation rate at the room supply diffusers should be calculated as:

$$q_{V;ODA} = \frac{q_{V,bz}}{\varepsilon_V} \qquad (14)$$

where

$q_{V,bz}$ is breathing zone ventilation rate (M1-6)

$q_{V;ODA}$ is the ventilation outdoor air volume flow

$$\varepsilon_V = \frac{C_e - C_s}{C_i - C_s} \qquad (15)$$

where

ε_v Ventilation effectiveness

C_e Pollutant concentration in extract air

C_s Pollutant concentration in supply air

C_i Pollutant concentration at breathing level

For default values for ventilation effectiveness see A.4.1 or B.4.1.

10.2 Calculation of air volume flows

10.2.1 Design air volume flow design based on heating, cooling loads and dehumidification

The minimum ventilation rate can be determined by the requirements for the heating and cooling load. If for this reason the ventilation rate becomes much higher than that for indoor air quality, an alternative solution for the dissipation of the heat could be more energy-efficient.

The required ventilation rate for heating or cooling is calculated from the following:

$$q_{\text{v,SUP}} = \frac{\Phi}{\rho \times c_{\text{p}} \ \left|\theta_{\text{a,IDA}} - \theta_{\text{SUP}}\right|} \quad (16)$$

where

$q_{\text{V,SUP}}$ is the volume flow rate of supply air in $m^3.s^{-1}$

Φ is the thermal load in W

ρ is the density of air in $kg.m^{-3}$

c_{p} is the thermal capacity of air in $J.kg^{-1}.K^{-1}$

$\theta_{\text{a,IDA}}$ is the temperature of the room air in °C

θ_{SUP} is the temperature of the supply air in °C

The density and the thermal capacity of air are dependent on its temperature and pressure. The calculation shall be made with the values applicable to the real situation.

The required ventilation rate for humidifying or dehumidifying is calculated as follows:

$$q_{V,SUP} = \frac{\dot{m}_h \times v_{SUP}}{x_{IDA} - x_{SUP}} \quad (17)$$

where

$q_{\text{V,SUP}}$ is the volume flow rate of supply air in $m^3.s^{-1}$

$\dot{m}_h$ is the humidity load in kg/s

v_{SUP} is the specific volume of supply air in $m^3\ kg^{-1}$dry air

x_{IDA} is the specific humidity of indoor air kg kg^{-1} dry air

x_{SUP} is the specific humidity of supply air kg kg^{-1} dry air

10.2.2 Extract airflow rates

Extract air rates from kitchens and hygiene rooms shall be specified. Demand controlled systems shall be preferred. The extract air can be replaced by outside air or by transferred air from other rooms depending on extract air quality and desired supply air quality (see 8.2.6). Extract air flows shall not create over 20 Pa underpressure into the building.

NOTE 1 An underpressure of 20 Pa might be too high considering the design of the air transfer devises and transportation of pollutants in filtrating through the structure.

NOTE 2 Typical and default design values for kitchen and toilets/washrooms are given in FprCEN/TR 16798-4.

10.3 Energy rating of ventilation systems

10.3.1 General

For EPBD energy performance calculations, the data described in 8.8.2 to 8.8.4 shall be calculated.

10.3.2 Specific Fan Power of an entire building

Specific fan power of an entire building (kW/(m^3/s) shall be calculated according to 8.5.4 and the specific fan power for each AHU shall be calculated according to 8.5.6 under reference (P_{SFP}) and design load conditions (P_{SFPd}).

10.3.3 Heat recovery efficiency

The annual energy efficiency of the heat recovery is calculated based on recovered energy and heating need of ventilation.

$$\varepsilon_{SUP} = 1 - \frac{Q_{H;V;in;req}}{Q_{H;V;tot}} \quad (18)$$

where

ε_{SUP} is the annual energy efficiency of heat recovery

$Q_{H;V;in;req}$ is annual heating energy of ventilation supply (or/and intake) air (M5-8) including defrosting, in kWh

$Q_{H;V;tot}$ is annual heating energy of supply (or/and intake) air without heat recovery (M5-8), in kWh

Annual heating energy of ventilation may be calculated for one ventilation system or for all ventilation systems in the building depending on the purpose of the calculation.

Coefficient of performance of heat recovery of AHU shall be calculated according to EN 13053:

$$\varepsilon = \frac{Q_{hr}}{E_{V;hr;gen;in;el}} \quad (19)$$

where

$\varepsilon_{AHυ}$ is Coefficient of performance

Q_{hr} is kW Heat transferred by heat recovery

EV;hr;gen;in;el is kW Electric energy of the heat recovery section required by fans and auxiliaries

10.3.4 Primary energy use of ventilation

Primary energy use of ventilation may be calculated as follows:

$$E_{P,AHU} = \frac{(E_V + W_{V,aux} + W_{HU,aux}) \times f_{P,E} + Q_H \times f_{P,H} \times f_H + (Q_C + Q_{DH}) \times f_{P,C} \times f_C + E_{HU} \times f_{P,HU} \times f_{HU}}{q_{V,SUP,ahu,nom}} \quad (20)$$

where

$E_{P,AHU}$	specific primary energy use of ventilation in Wh/(m^3/h·a)
E_V	required energy to be supplied by the electrical heating
Q_H	required AHU heating coil input in Wh/(m^3/h·a)
Q_C	required AHU cooling coil input in Wh/(m^3/h·a)
Q_{DH}	required AHU dehumidification input in Wh/(m^3/h·a)
E_{HU}	required AHU humidification input in Wh/(m^3/h·a)
f_H	Delivered energy factor for heat (taking into consideration distribution and generation)
f_C	Delivered energy factor for cold (taking into consideration distribution and generation)
f_{HU}	Delivered energy factor for humidification (taking into consideration distribution and generation)
$f_{P,HU}$	Primary energy factor of carrier required by the humidifier
$f_{P,E}$	Primary energy factor for electricity
$f_{P,H}$	Primary energy factor for heat
$w_{V;aux}$	ventilation auxiliary energy in Wh/(m^3/h·a)
$w_{HU;aux}$	humidification auxiliary electrical energy in Wh/(m^3/h·a)

The specific values in Formula 18 are calculated by dividing corresponding absolute values with nominal air flow rate *qV;SUP;ahu;nom.*

Annex A
(normative)

Input and method selection data sheet — Template

A.1 General

The template in Annex A to this standard shall be used to specify the choices between methods, the required input data and references to other standards.

NOTE 1 Following this template is not enough to guarantee consistency of data.

NOTE 2 Informative default choices are provided in Annex B. Alternative values and choices can be imposed by national / regional regulations. If the default values and choices of Annex B are not adopted because of the national / regional regulations, policies or national traditions, it is expected that:

— national or regional authorities prepare data sheets containing the national or regional values and choices, in line with the template in Annex A; or

— by default, the national standards body will add or include a national annex (Annex NA) to this standard, in line with the template in Annex A, giving national or regional values and choices in accordance with their legal documents.

NOTE 3 The template in Annex A is applicable to different applications (e.g. the design of a new building, certification of a new building, renovation of an existing building and certification of an existing building) and for different types of buildings (e.g. small or simple buildings and large or complex buildings). A distinction in values and choices for different applications or building types could be made:

— by adding columns or rows (one for each application), if the template allows;

— by including more than one version of a table (one for each application), numbered consecutively as a, b, c, ... For example: Table NA.3a, Table NA.3b.

— by developing different national / regional data sheets for the same standard. In case of a national annex to the standard these will be consecutively numbered (Annex NA, Annex NB, Annex NC, ...).

NOTE 4 In the section "Introduction" of a national / regional data sheet information can be added, for example about the applicable national / regional regulations.

NOTE 5 For certain input values to be acquired by the user, a data sheet following the template of Annex A, could contain a reference to national procedures for assessing the needed input data. For instance, reference to a national assessment protocol comprising decision trees, tables and pre-calculations.

The shaded fields in the tables are part of the template and consequently not open for input.

A.2 References

The references, identified by the module code number, are given in Table A.1.

Table A.1 —References

Reference	Reference document
M1-6	
M1-9	
M1-13	
M2-2	
M2-6	
M3-3	
M3-5	
M4-5	
M5-6-1	
M5-6-2	

A.3 Design data for energy calculation

A.3.1 Typical range for SFP categories

Table A.2 shows typical categories of SFP depending on functions.

Table A.2 — Typical range for the category of SFP

Application	Category of SFP for each fan	
	Typical range	value
Supply air fan - air- conditioning system - simple ventilation system	SFP 1 to SFP 5 SFP 1 to SFP 4	
Extract air fan - air-conditioning system, or ventilation system with heat recovery - simple ventilation system	SFP 1 to SFP 5 SFP 1 to SFP 4	

A.4 Design data

A.4.1 Effectiveness of ventilation and air distribution

The ventilation effectiveness depends on individual design aspects and might change depending on temperature, air volume flow, air distribution and thermal loads.

Without individual project design, the factor for ventilation effectiveness shall be:

ε_v = …

A.4.2 Filtration

Table A.3 is presented to simplify the selection of air filter to comply with particle removal efficiencies described in Table 17.

Table A.3 is valid for unidirectional supply air units and the supply air path of bidirectional ventilation units.

Table A.3 — Recommended minimum filter classes per filter section (definition of filter classes according to EN 779)

Outdoor air quality					
	SUP 1	SUP 2	SUP 3	SUP 4	SUP 5
ODA 1					
ODA 2					
ODA 3					

To maintain a good sanitary level in the ventilation system the minimum combined filtration efficiency needs to meet filtration class … in accordance with EN 779.

A.4.3 Outdoor air classification

As a starting point, the following approach shall be followed.

ODA 1 …

ODA 2 …

ODA 3 …

A.4.4 Leakage at Air Handling unit (AHU) casing

The minimum leakage class is ___

A.4.5 Leakage in air distribution systems

The minimum leakage class in air distribution systems is ___. Class ___ is recommended.

Annex B
(informative)

Input and method selection data sheet — Default choices

B.1 General

The template in Annex A to this standard shall be used to specify the choices between methods, the required input data and references to other standards.

NOTE 1 Following this template is not enough to guarantee consistency of data.

NOTE 2 Informative default choices are provided in Annex B. Alternative values and choices can be imposed by national / regional regulations. If the default values and choices of Annex B are not adopted because of the national / regional regulations, policies or national traditions, it is expected that:

— national or regional authorities prepare data sheets containing the national or regional values and choices, in line with the template in Annex A; or

— by default, the national standards body will add or include a national annex (Annex NA) to this standard, in line with the template in Annex A, giving national or regional values and choices in accordance with their legal documents.

NOTE 3 The template in Annex A is applicable to different applications (e.g. the design of a new building, certification of a new building, renovation of an existing building and certification of an existing building) and for different types of buildings (e.g. small or simple buildings and large or complex buildings). A distinction in values and choices for different applications or building types could be made:

— by adding columns or rows (one for each application), if the template allows;

— by including more than one version of a table (one for each application), numbered consecutively as a, b, c, … For example: Table NA.3a, Table NA.3b.

— by developing different national / regional data sheets for the same standard. In case of a national annex to the standard these will be consecutively numbered (Annex NA, Annex NB, Annex NC, …).

NOTE 4 In the section "Introduction" of a national / regional data sheet information can be added, for example about the applicable national / regional regulations.

NOTE 5 For certain input values to be acquired by the user, a data sheet following the template of Annex A, could contain a reference to national procedures for assessing the needed input data. For instance, reference to a national assessment protocol comprising decision trees, tables and pre-calculations.

The shaded fields in the tables are part of the template and consequently not open for input.

B.2 References

The default references, identified by the module code number, are given in Table B.1.

Table B.1 —References

Reference	Reference document
M1-6	EN 16798-1 Energy performance of buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics - Module M1-6
M1-9	EN ISO 52000-1 Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures
M1-13	EN ISO 52010-1 Energy performance of buildings — Overarching assessment procedures for external environment conditions — Part 1: Conversion of measured hourly weather data to input for energy calculations
M2-2	EN ISO 52016-1 Energy performance of buildings — Calculation of the energy needs for heating and cooling, internal temperatures and heating and cooling load in a building or building zone — Part 1: Calculation procedures
M2-6	EN ISO 52016-1 Energy performance of buildings — Calculation of the energy needs for heating and cooling, internal temperatures and heating and cooling load in a building or building zone — Part 1: Calculation procedures
M3-3	EN 12831-1 Heating systems and water based cooling systems in buildings — Method for calculation of the design heat load — Part 1: Space heating load
M3-5	EN 15316-2 Heating systems and water based cooling systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 2: Space emission systems (heating and cooling)
M4-5	EN 15316-2 Heating systems and water based cooling systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 2: Space emission systems (heating and cooling)
M5-6-1	EN 16798-5-1 Energy performance of buildings - Part 5: Ventilation for buildings - Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 - Calculation methods for energy requirements of ventilation and air conditioning systems (revision of EN 15241) – method 1
M5-6-2	EN 16798-5-2 Energy performance of buildings - Part 5: Ventilation for buildings - Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 - Calculation methods for energy requirements of ventilation and air conditioning systems (revision of EN 15241) – method 2
M5-5	EN 16798-7 Energy performance of buildings — Module M5-5 — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 7: Emission (determination of air flow rates, revision of EN 15242)
M4-1	EN 16798-9 Energy performance of buildings — Module M4-1, M4-4, M4-9 - Ventilation for buildings - Calculation methods for energy requirements of cooling systems —Part 9: General and energy performance expression
M4-4	EN 16798-9 Energy performance of buildings — Module M4-1, M4-4, M4-9 - Ventilation for buildings - Calculation methods for energy requirements of cooling systems —Part 9: General and energy performance expression
M4-9	EN 16798-9 Energy performance of buildings — Module M4-1, M4-4, M4-9 - Ventilation for buildings - Calculation methods for energy requirements of cooling systems —Part 9: General and energy performance expression
M4-3	ISO 50017
M4-8	EN 16798-13 Energy performance of buildings — Module M4-8 - Ventilation for buildings -methods for the calculation of the energy performance of cooling systems — Part 13: Generation
M4-11	EN 16798-1 Energy performance of buildings —Part 17: Ventilation for buildings Module M4-11, M5-11, M6-11, M7-11 Guidelines for inspection of ventilation and air conditioning systems

Reference	Reference document
M5-11	EN 16798-1 Energy performance of buildings —Part 17: Ventilation for buildings Module M4-11, M5-11, M6-11, M7-11 Guidelines for inspection of ventilation and air conditioning systems
M6-11	EN 16798-1 Energy performance of buildings —Part 17: Ventilation for buildings Module M4-11, M5-11, M6-11, M7-11 Guidelines for inspection of ventilation and air conditioning systems
M7-11	EN 16798-1 Energy performance of buildings —Part 17: Ventilation for buildings Module M4-11, M5-11, M6-11, M7-11 Guidelines for inspection of ventilation and air conditioning systems
M9	EN 15193 Energy performance of buildings - Module M9 - Energy requirements for lighting
M10	EN 15232 Energy performance of buildings - Part 1: Impact of Building Automation, Controls and Building Management -Modules M10-4,5,6,7,8,9,10

B.3 Default design data for energy calculation

B.3.1 Typical range for SFP categories

Table B.2 shows typical categories of SFP depending on functions.

Table B.2 — Typical range for the category of SFP

Application	Category of SFP for each fan	
	Typical range	Default value
Supply air fan - air- conditioning system - simple ventilation system	SFP 1 to SFP 5 SFP 1 to SFP 4	SFP 4 SFP 3
Extract air fan - air-conditioning system, or ventilation system with heat recovery - simple ventilation system	SFP 1 to SFP 5 SFP 1 to SFP 4	SFP 3 SFP 2

B.4 Default design data

B.4.1 Effectiveness of ventilation and air distribution

The ventilation effectiveness depends on individual design aspects and might change depending on temperature, air volume flow, air distribution and thermal loads.

Without individual project design, the factor for ventilation effectiveness shall be:

$$\varepsilon_v = 1$$

B.4.2 Filtration

This table is presented to simplify the selection of air filter to comply with particle removal efficiencies described in Table 16 in 9.7.1.

Table B.3 is valid for unidirectional supply air units and the supply air path of bidirectional ventilation units.

Table B.3 — Recommended minimum filter classes per filter section (definition of filter classes according to EN 779)

Outdoor air quality					
	SUP 1	SUP 2	SUP 3	SUP 4	SUP 5
ODA 1	M5+F7	F7	F7	F7	-
ODA 2	F7 + F7	M5 + F7	F7	F7	- G3,M5?
ODA 3	F7 + F9	F7 + F7	M6 + F7	F7	F7

To maintain a good sanitary level in the ventilation system the minimum combined filtration efficiency of mechanical supply air needs to meet filtration class F7 in accordance with EN 779.

B.4.3 Outdoor air classification

As a starting point, the following approach shall be followed.

ODA 1 applies where the World Health Organisation WHO (2005) guidelines and any National air quality standards or regulations for outdoor air are fulfilled.

ODA 2 applies where pollutant concentrations exceed the WHO guidelines or any National air quality standards or regulations for outdoor air by a factor of up to 1,5.

ODA 3 applies where pollutant concentrations exceed the WHO guidelines or any National air quality standards or regulations for outdoor air by a factor greater than 1,5.

Since there are neither guidelines nor regulations for all pollutants, and those that do exist are not uniform between nations, informed interpretation is required on the part of the designer. The potential impact of mixtures of pollutants, not just individual pollutants, shall be considered.

Typical gaseous pollutants to be considered in the evaluation of the outdoor air for the design of ventilation and room-conditioning systems are carbon monoxide, sulphur dioxide, oxides of nitrogen and volatile organic compounds (VOCs). When judging the harmfulness gaseous pollution both the toxicity and the reactiveness of the gas should be considered.

Particulate matter refers to the total amount of solid or liquid particles in the air, from the visible dust to submicron particles. Many outdoor air guidelines refer to PM_{10} (particulate matter with an aerodynamic diameter up to 10 µm) but there is growing acceptance that, for the purpose of health protection, greater emphasis shall be placed on smaller particles and use as a criteria particle concentration up to 2,5 µm ($PM_{2,5}$)

as a limit value. WHO gives guideline values for PM_{10} and $PM_{2,5}$.. If ODA data are available, both shall be considered.

Where biological particles need to be considered particle concentration is not a relevant criteria, instead microbiological quality of the air shall be considered..

NOTE Further information about outdoor air quality and how to determine the ODA class is given in FprCEN/TR 16798-4.

Supply air classification

As a starting point, the following approach is suggested.

— SUP1 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations with a factor x0,25

— SUP2 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations with a factor x0,5

— SUP3 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations with a factor x0,75

— SUP4 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations.

— SUP5 applies where the supply air fulfils the WHO (2005) guidelines limit values and any National air quality standards limit values or regulations with a factor x 1,5

B.4.4 Leakage at Air Handling unit (AHU) casing

The minimum leakage class is L3. Class L2 according to EN 1886 is recommended.

B.4.5 Leakage in air distribution systems

The minimum leakage class in air distribution systems is B. Class C is recommended.

Bibliography

[1] EN 1507, *Ventilation for buildings — Sheet metal air ducts with rectangular section — Requirements for strength and leakage*

[2] EN 1751, *Ventilation for buildings — Air terminal devices — Aerodynamic testing of damper and valves*

[3] EN 12237, *Ventilation for buildings — Ductwork — Strength and leakage of circular sheet metal ducts*

[4] EN 13180, *Ventilation for buildings — Ductwork — Dimensions and mechanical requirements for flexible ducts*

[5] EN 13403, *Ventilation for buildings — Non-metallic ducts — Ductwork made from insulation ductboards*

[6] CEN/TR 14788, *Ventilation for buildings — Design and dimensioning of residential ventilation systems*

[7] EN 15193, *Energy performance of buildings — Energy requirements for lighting*

[8] EN 15727, *Ventilation for buildings — Ducts and ductwork components, leakage classification and testing*

[9] CEN/TS 16628, *Energy Performance of Buildings — Basic Principles for the set of EPB standards*

[10] CEN/TS 16629, *Energy Performance of Buildings — Detailed Technical Rules for the set of EPB-standards*

[11] EN ISO 10121-1, *Test method for assessing the performance of gas-phase air cleaning media and devices for general ventilation — Part 1: Gas-phase air cleaning media (ISO 10121-1)*

[12] EN ISO 10121-2, *Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation — Part 2: Gas-phase air cleaning devices (GPACD) (ISO 10121-2)*

[13] EN ISO 12759, *Fans — Efficiency classification for fans (ISO 12759:2010, including Amd 1)*