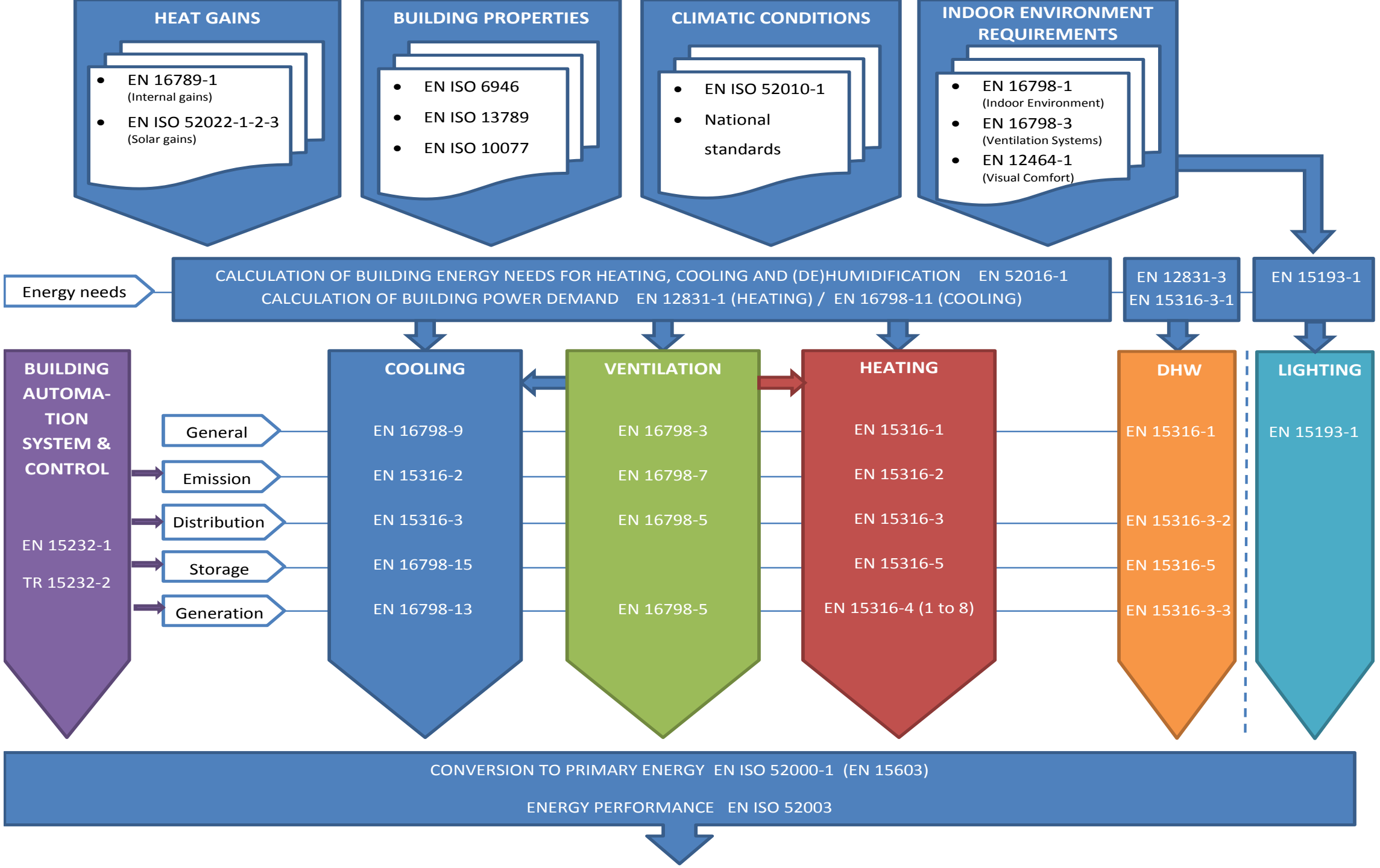
EN 16798 -1….16798 -18 [> 1000 pages]
ISO 52016 -1; 52016 -2; 52017-1

VENTILATION AND AIR CONDITIONING; THE NEW EPB STANDARDS AND REVISED MC001 METHODOLOGY

Iolanda Colda , Andreea Vartires


HEAT GAINS
EN 16789-1 (Internal gains)
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BUILDING PROPERTIES
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NUMBER	TITLE
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)**
EN 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 16798-1**
EN 16798-3	**Energy performance of buildings — Part 3: Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems** **(revision of EN 13779)**
EN 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 16798-3**
EN 16798-5-1	**Energy performance of buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 5-1: Distribution and generation — Method 1** **(revision of EN 15241)**
EN 16798-5-2	**Energy performance of buildings — Modules M5-6.2, M5-8.2 — Ventilation for buildings — Calculation methods for energy requirements of ventilation systems — Part 5-2: Distribution and generation — Method 2** **(revision of EN 15241)**

NUMBER	TITLE
EN 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 16798-5-1 and EN 16798-5-2
EN 16798-7	Energy performance of buildings — Part 7: Ventilation for buildings — Modules 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)
EN 16798-8	Energy performance of buildings — Part 8: Ventilation for buildings — Modules 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 16798-7
EN 16798-9	Energy performance of buildings — Part 8: Ventilation for buildings — Modules 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 16798-7
EN 16798-10	Energy performance of buildings — Part 9: Ventilation for buildings — Module M4-1, M4-4, M4-9 — Calculation methods for energy requirements — Calculation methods for energy requirements of cooling systems — General (revision of EN 15243)
EN 16798-11	Energy performance of buildings — Part 10: Ventilation for buildings — Methods for the calculation of the energy performance of cooling systems — General — Technical report — Interpretation of the requirements in EN 16798-9 — Modules M4-1, M4-4, M4-9
EN 16798-12	Energy performance of buildings — Part 8: Ventilation for buildings — Modules 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 16798-7

NUMBER	TITLE
EN 16798-13	Energy performance of buildings — Part 13: Module M4-8 — Calculation of cooling systems — Generation
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
EN 16798-15	Energy performance of buildings — Part 15: Module M4-7 — Calculation of cooling systems — Storage
CEN/TR 16798-16	Energy performance of buildings — Module M4-7 — Calculation of cooling systems — Storage — Part 16: Technical report — Explanation of the requirements of EN 16798-15
EN 16798-17	Energy performance of buildings — Part 17: Ventilation for buildings — Guidelines for inspection of ventilation and air conditioning systems, Module M4-11, M5-11, M6-11, M7-11
EN 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

NUMBER	TITLE
ISO 52016-1	Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads . Part 1: Calculation procedures
CEN ISO TR 52016-2	Energy performance of buildings - Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads - Part 2: Explanation and justification of ISO 52016-1 and ISO 52017-1 (ISO/TR 52016-2:2017)
ISO 52017-1	Energy performance of buildings — Sensible and latent heat loads and internal temperatures — Part 1: Generic calculation procedures

Adults consume this much air, water and food per day

EN 16798-1 M1-6 Part 1: Indoor environmental input parameters
EN 16798-2 Part 2: Technical report — Interpretation of the requirements in EN 16798-1

Total ventilation rate

$q_{supply} = q_{tot} / \varepsilon_v$

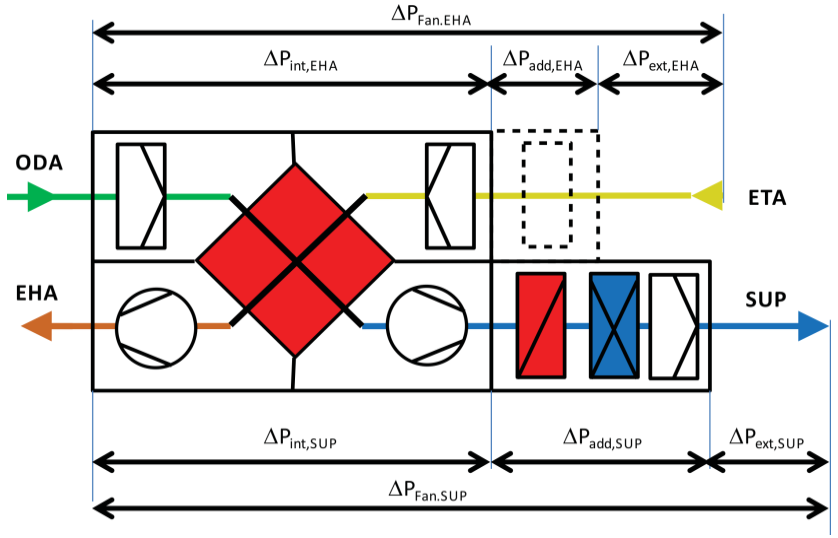
where

- ε_v = the ventilation effectiveness* (EN13779 or future EN156798-3 by default = 1)
- q_{supply} = ventilation rate supplied by the ventilation system
- q_{tot}= total ventilation rate for the breathing zone, l/s

  $q_{tot}=n.q_p+A_R.q_B$ (idem I5 Norm; q_p and q_B different values)
- n = design value for the number of the persons in the room,
- q_p = ventilation rate for occupancy per person, l/s, pers
- A_R= room floor area, m^2
- q_B = ventilation rate for emissions from building, l/s,m^2

HEALTH CRITERIA FOR VENTILATION MINIMUM 15 m3/h.person

* red colour – new prescription



EN 16798-3 Part 3: Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems
EN 16798- 4 Part 4: Technical report — Interpretation of the requirements in EN 16798-3

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.
It are mainly applicable to mechanical supply and/or exhaust ventilation systems.
It is very well organized, uses tables and acronyms (the same for all standards)

Sets rules for increasing energy efficiency
Example: 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

EN 16798-3 standard, former EN13779, done:

— update of **filtration** aspects;

— update of **heat recovery** aspects and **leakages** in these systems;

— **supply air quality have been introduced**;

— aspects of energy performance have been updated;

— update of **definitions of systems**;

— update of SPF definitions;

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

— develops specification of **types of air**

— treats **leakages** in ventilation systems

— treats ventilation **effectiveness and air diffusion**

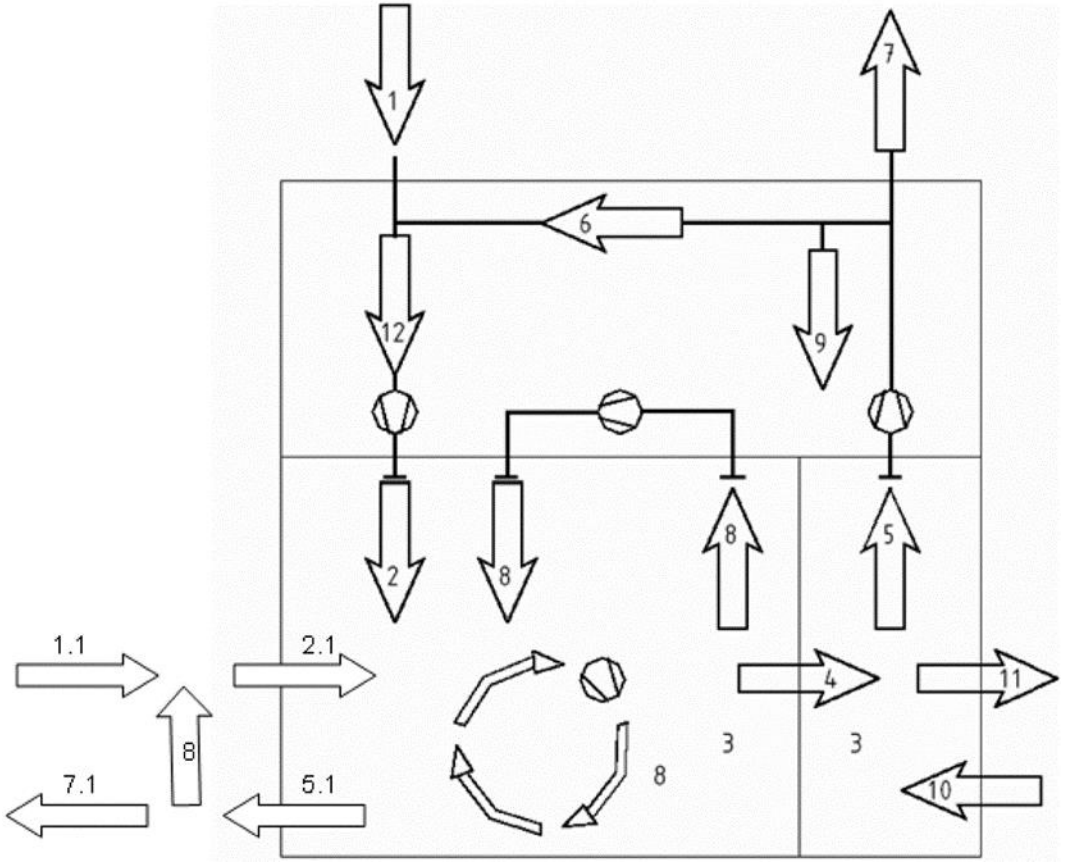


Illustration of types of air

Example: **Choice of filters** is based on the supply air and outdoor air classification:
Supply air classification.

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

— SUP2 idem with a factor x0,5 — SUP3 idem with a factor x0,75

— SUP4 idem with a factor x1 —SUP5 idem with a factor x1,5

Outdoor air classification

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.

Recommended minimum filter classes per filter section

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	M 5
ODA 3	F7 + F9	F7 + F7	M6 + F7	F7	F7

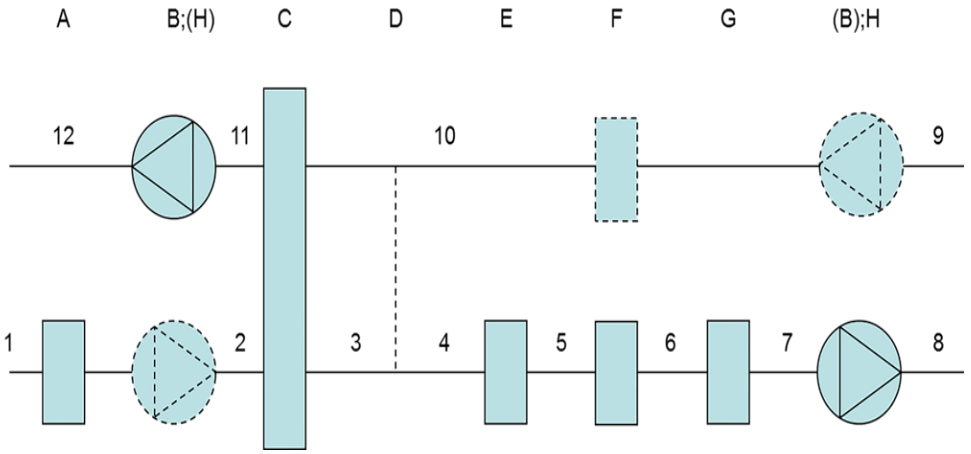
EN 16798-5-1 Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems - Part 5-1: Distribution and generation - Method 1. M5-6, M5-8, M6-5, M6-8, M7-5, M7-8; Part 5-2: Method 2
EN 16798-6 Technical report — Interpretation of the requirements in EN 16798-5-1 and EN 16798-5-2

This European Standard covers **the energy performance calculation** of mechanical ventilation and air conditioning systems, including humidification and dehumidification.

It takes into account **the generation (air handling unit) and distribution (duct system) parts**. It includes a simplified calculation of **adiabatic** cooling systems. This method is focused on large customized ventilation and air conditioning systems, typically used in **commercial buildings**, although the application is not restricted on the basis of building or space use type.

A calculation method for ventilation systems with **integrated heating/cooling generation**, including domestic hot water generation, using a monthly or seasonal calculation interval or a bin method, is provided in a separate standard, EN 16798-5-2. This method does not include humidification and dehumidification or adiabatic cooling

Generation calculation



Treatment stage	Air type		Subscript
frost protection / ground preheating/-cooling	1	outdoor air	ODA
exhaust air fan	2	preheated outdoor air	ODA;preh
heat recovery	3	supply air after heat recovery	SUP;hr
recirculation	4	supply air after recirculation[a]	SUP;RCA
cooling / dehumidification	5	supply air after cooling/dehumidification	SUP;C
humidification	6	supply air after humidification	SUP;hu
heating	7	supply air after heating	SUP;rh
supply fan	8	supply air entering the distribution system	SUP;dis;in
	9	extract air leaving the distribution system	ETA;dis;out
	10	extract air entering the heat recovery / recirculation	ETA;hr;in
	11	extract air after heat recovery	ETA;hr;out
	12	exhaust air	EHA

Generation calculation

Air flow rates in the air handling unit (example)

The volume air flow rate supplied is calculated as follows:

— If AIR_FLOW_CTRL = NO_CTRL (no flow rate control, continuous operation)

$$q_{V;SUP;dis;in} = q_{V;SUP;ahu;nom} \quad (23a)$$

— If AIR_FLOW_CTRL = ON/OFF_CTRL (time dependent flow rate control, continuous operation during occupancy time)

$$q_{V;SUP;dis;in} = f_{op;V} \cdot q_{V;SUP;ahu;nom} \quad (23b)$$

— If AIR_FLOW_CTRL = MULTI_STAGE (multi stage variable flow rate control) ....

Supply temperature control and energy calculation

Temperature rise in the fan

Ground air preheating and -cooling

Recirculation

Heat recovery

Frost protection

Adiabatic cooling

Final supply air conditions

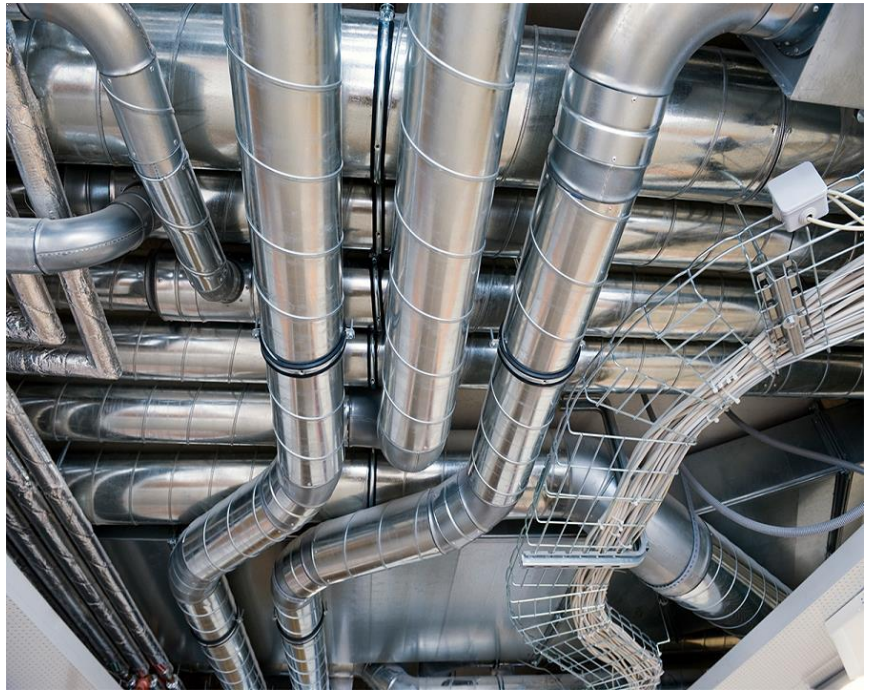
Distribution calculation

Operating conditions calculation

- Volume flow rates
- Air temperature and humidity change in the ductwork

Energy calculation

- Distribution heat losses
- Recoverable distribution heat losses



The required volume flow rates to be provided by the air handling unit to the distribution duct system are:

$$q_{V;SUP;dis;in;req} = \sum_{i} (f_{lea;du;SUP} \cdot q_{V;SUP;dis;zv;req;i})$$

$q_{V;SUP;dis;zv;req;i}$ is the required volume flow rate for the ventilation zone i;

$f_{lea:du;SUP}$ is the duct leakage factor (1 – 1,45 for different duct tightness class)

This European Standard describes the method to calculate the **ventilation air flow rates** for buildings to be used for energy calculations evaluation, heating and cooling loads.

EN 16798-7 Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration
M5-1, M5-5, M5-6, M5-8
EN 16798-8 Technical report — interpretation of the requirements in EN 16798-07

This European Standard applies to buildings with following characteristics:

— **mechanical ventilation systems** (mechanical exhaust, mechanical supply or balanced system);

— **passive duct ventilation systems** for residential and low-rise non-residential buildings;

— combustion appliances; — window openings (manual or automatic operation); and

— kitchens where cooking is for immediate use (including restaurants).

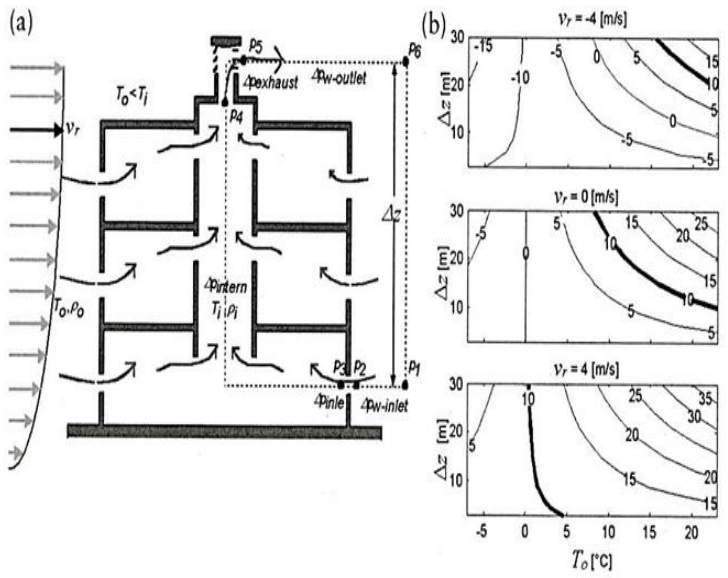
This European Standard is applicable to hybrid systems combining mechanical and passive duct ventilation systems in residential and low-rise non-residential buildings.

This European Standard applies to buildings with a building height of less than 100 m and rooms where vertical air temperature difference is smaller than 15 K.

The results provided by the standard are:

— **the air flow rates entering or leaving a ventilation zone**; and

— the air flow rates **required to be distributed by the mechanical** ventilation system, if present.



Source: (a) Axley (2001)

mbined wind- and buoyancy-driven ventilation: (a) pressure drops; (b) total pressure as a function of wind velocity, temperature difference and building height

Example

Passive duct ventilation systems for residential and low-rise non-residential buildings.

Calculation procedure:

output of the methods

This document gives the air flow rates entering and leaving each ventilation zone in a building including infiltration.

The air flow rate through a passive duct is characterized by:

— the pressure loss at the internal air terminal devices;

— the pressure losses in the ductwork; — the pressure loss at the cowl; and

— the useful height for stack effect.

— switching to mechanical ventilation with hybrid systems

given **operating conditions:**

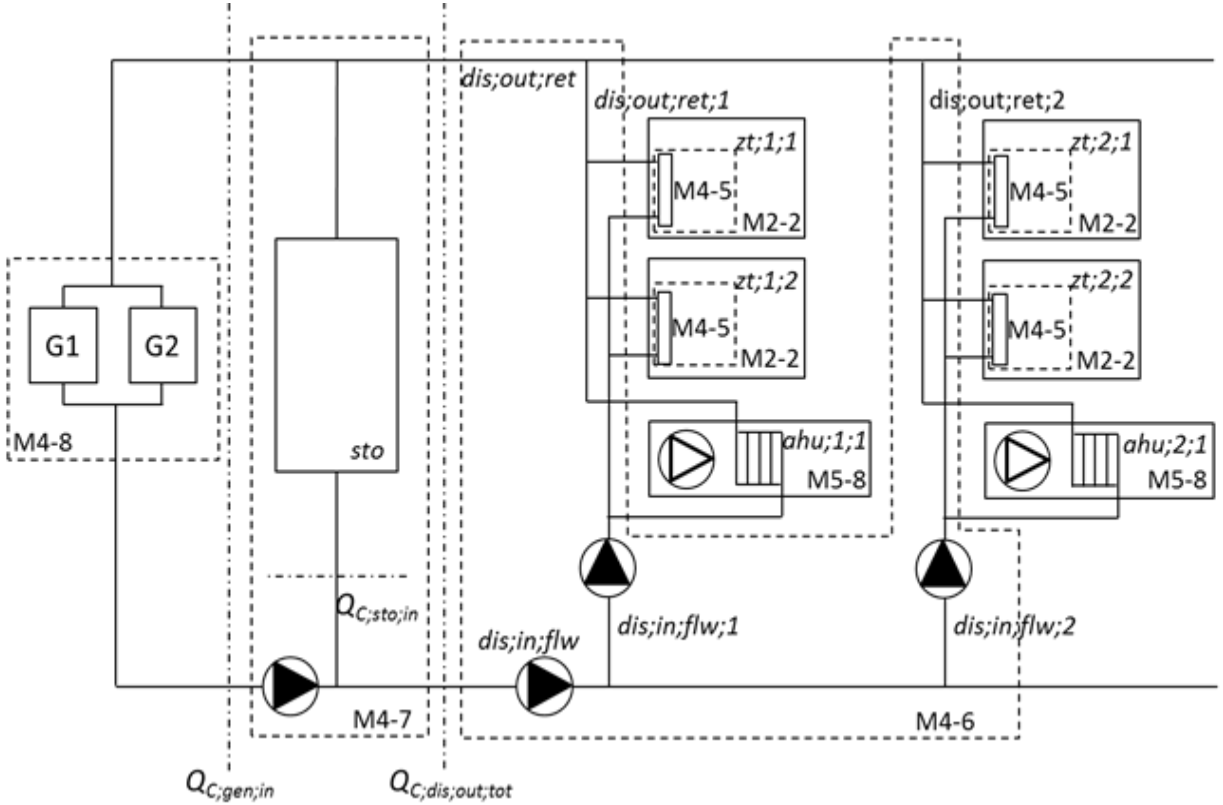
— Reference wind speed at site
— Pressure coefficients associated to an air flow path
— Pressure difference at an air flow path
— Required supply air temperature for mechanical ventilation air condition calculations

EN 16798-9 Energy performance of buildings — Ventilation for buildings — Part 9: Calculation methods for energy requirements of cooling systems General; M4-1
EN 16798-10 Part 10: Technical report — Interpretation of the requirements in EN 16798-9

This standard covers the **energy performance calculation of complete cooling systems**.
It gives a calculation method which defines how to collect the cooling energy requirements from the thermal zones and from the air handling units connected to a distribution system, and how to aggregate multiple distribution systems to an overall system energy requirement. It integrates the calculation of the emission and distribution losses and auxiliary energy.

The **required cooling energy to be extracted by the cooling generation system** is calculated, considering cooling energy storage. It gives a method on how to dispatch the cooling energy provided by the cooling generation to different distribution systems, considering possible priorities.

This standard defines technical system related energy performance indicators for cooling systems.



Relation to modules, boundaries and involved indices

The method covers the calculation of:
— the required cooling generation outlet temperature;
— the flow and return water temperatures in the cooling distribution systems, based on the required values;
— the volume flow rates of the cooling distribution systems;
— the required cooling energy to be extracted by the cooling generation system, based on the requirements of the thermal zones and the air handling units calculated according to the module M2-2 and M5-8 standards;

— the cooling energy extracted from the distribution systems, based on the cooling energy extracted by the generation system according to the M4-8 standard and possible storage effects according to the M4-7 standard, considering possible priorities;
— the cooling energy extracted from the thermal zones and the air handling units, considering the emission losses according to the M4-5 standard and the distribution losses according to the M4-6 standard; and
— technical system performance indicators for cooling systems.

example

6.4.3 Energy calculation

6.4.3.1 Energy extracted from thermal zones and air handling units

The energy really extracted from the thermal zone j and from the air handling unit k at the current calculation interval is:

$$Q_{C;zt,j} = \min\left[Q_{C;nd;zt,j} \; ; \; \frac{Q_{C;nd;zt,j}}{Q_{C;genin;req}} \cdot Q_{C;gen;in}\right] \qquad Q_{C;ahu,k;out} = \min\left[Q_{C;ahu,k;out;req} \; ; \; \frac{Q_{C;ahu,k;out;req}}{Q_{C;gen;in;req}} \cdot Q_{C;gen;in}\right] \qquad (7), (8)$$

where

	$Q_{C;nd;zt,j}$	kWh	is the sensible energy need for cooling in thermal zone j
	$Q_{C;em,ls;j}$	kWh	are the heat losses of the cooling emission in thermal zone j
	$Q_{C;ahu,k;out;req}$	kWh	is the required cooling energy in air handling unit k
	$Q_{C;gen;in}$	kWh	is the energy extracted by the cooling generation system at the current calculation interval

6.4.3.2 Direct expansion systems

The required energy to be extracted by the cooling generation system at the current calculation interval is:

$$Q_{C;gen;in;req} = \sum_j Q_{C;nd;zt,j} + \sum_j Q_{C;em;ls,j} + \sum_k Q_{C;ahu,k;out;req} \qquad (9)$$

6.4.3.3 Water based systems

The required energy to be extracted by the cooling generation system at the current calculation interval is:

$$Q_{C;gen;in;req} = \sum_j Q_{C;nd;zt,j} + \sum_j Q_{C;em;ls,j} + \sum_k Q_{C;ahu,k;out;req} + Q_{C;dis;ls} + f_{wat;C;aux;dis} \cdot W_{C;aux;dis} \qquad (10)$$

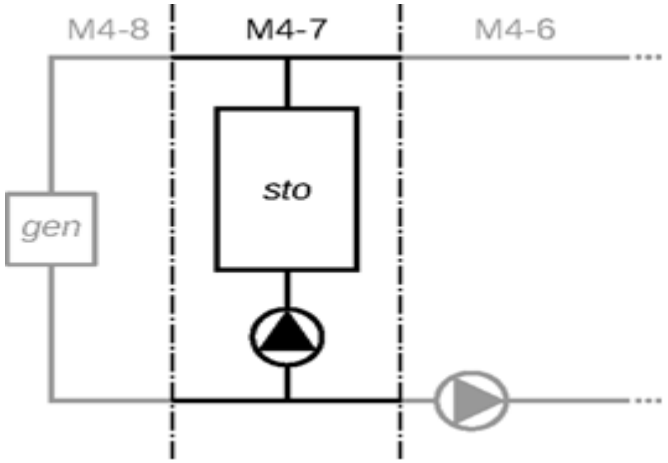
where

	$f_{wat;C;aux;dis}$	—	is the fraction of the auxiliary energy going to the chilled water.

EN 16798-13 Energy performance of buildings — Part 13: - Calculation of cooling systems - Generation
EN 16798-14 Part 14: Technical report — Interpretation of the requirements in EN 16798-13

This standard covers the calculation of the operational parameters and the energy consumption of cooling generation systems. The cooling generation consists of cooling generators like
- **compression** and **absorption** chillers;
- other (generic) generator types such as **ground** or surface water or direct use of ground heat from boreholes;
- different types of **heat rejection** (dry, wet, hybrid with outdoor air, other sink types).

The methods cover the possibility of heat recovery of heat to be rejected for the use of heating and/or domesti c hot water production, through the use of an interface to the M3- 1 standard; a multi generator calculation.
The document does not cover the cooling emission, distribution and storage systems, which are covered by the Module M4-5, M4-6 and M4-
7 standards, respectively. It is directly connected to the general part of the cooling systems, the M4-1 standard.



EN 16798 -15 Energy performance of buildings — Ventilation for buildings — Calculation of cooling systems — Storage
EN 16798 -16 : Technical report — Interpretation of the requirements in EN 16798-15

This standard gives the methods applicable to calculate the energy performance of the cooling storage systems.

This method covers the calculation of energy delivered to the storage system, energy delivered from the storage systems to distribution system, auxiliary energy and thermal losses (recoverable or not) of storage systems used for cooling. The time step of the output can be: hourly, bin, monthly, yearly, in accordance with the scenarios used to determine the thermal load.
Extension of the method .The method presented in this standard can be extended to storage systems with multiple storage units.
The adaptation depends on the hydraulic schema used for the design of the storage systems:

— serial mounting: the storage units are hydraulically linked as the output of the storage unit 'n' becomes the input of the storage unit 'n+1'. The formulae are identical as the calculation procedure considers a loop for all storage units to calculate the total energy stored, the energy used and delivered and the corresponding volume of hot water delivered to the system;
— parallel mounting: the control system sets the priority for the storage units that are considered independently.

This ES specifies the common methodology and the requirements for inspection of air conditioning systems in buildings for space cooling and/or heating and/or ventilation systems from an energy use standpoint. It can be used to fulfil the EPBD requirements as well as in other contexts. The methodology specified in this standard deals with indoor climate problems that can be due to the systems inspected.

EN 16798 -17 Energy performance of buildings – Ventilation for buildings - Guidelines for inspection of ventilation and air- conditioning systems EN 16798-18 EN 16798 -18: Technical report — Interpretation of the requirements in EN 16798-17

This standard applies to both residential and non-residential buildings equipped with:

— air conditioning system(s) without mechanical ventilation; or
— air conditioning system(s) with mechanical ventilation; or
— natural and mechanical ventilation system(s).

This standard is also applicable to some systems for which the Directive does not require inspection, such as:

— fixed systems of less than 12 kW output; — ventilation-only systems.

The inspection of systems given in this standard is applicable to:

— all types of comfort cooling and air conditioning systems. This includes air conditioning systems of an effective rated output of less than 12 kW not covered by Directive 2010/31/EU;
— all types of ventilation systems that is to say mechanical, natural, hybrid (including mechanical and natural ventilation). Parts of this standard are also applicable to check ventilation requirements when there is no ventilation system.

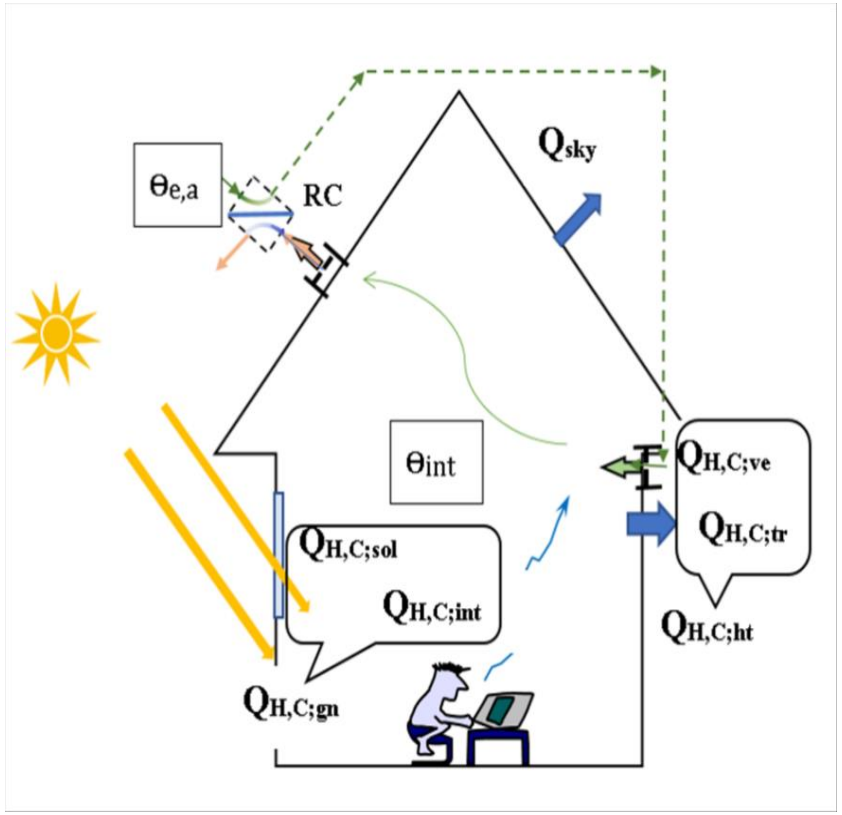
The inspection of systems includes but is not limited to the following components:

— reverse-cycle operation of air-conditioning equipment; — associated water and air distribution and exhaust systems that form a necessary part of the system; — controls that are intended to regulate the use of associated water and air distribution and exhaust systems.

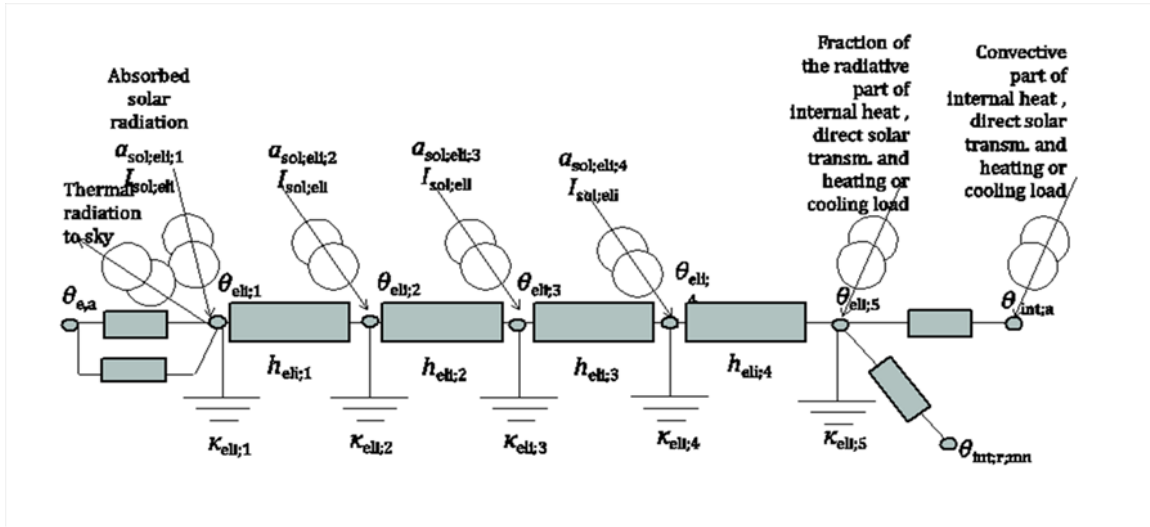
REVISED MC001 METHODOLOGY
ISO 52016 -1; 52016 -2; 52017-1 + 16798 series

CONTENT (actual)

drawn up according to specifications:



- the (sensible) energy need for heating and cooling, based monthl calculations;
- the latent energy need for (de)humidification, based on monthly calculations;
- the internal temperature, based on hourly calculations; ???



This document also contains specifications for the assessment of thermal zones in the building The calculations are performed per the rmal zone. In the calculations, the thermal zones can be assumed to b e thermally coupled or not

based on ISO 52016-1:

THANK YOU