CEN Standard EN 16798-3:2017 on ventilation for non-residential buildings: PERFORMANCE REQUIREMENTS

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Introduction

August 2017, CEN published the new standard EN 16798-3:2017 "Energy performance of buildings - Ventilation for buildings – Part 3: For non-residential buildings – Performance requirements for ventilation and room-conditioning systems (Modules M5-1, M5-4)", which supersedes the EN 13779:2007. 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", while the substituted EN 13779:2007 was produced to meet the requirements of previous Directive 2002/91/EC 16 December 2002 on energy performance of buildings referred to as "EPBD". Today, a new recast of the energy performance buildings directive is ongoing and should be finalized on April 2018 (see article page 70), but that should not have a significant influence on this specific standard at least for other ten years. This standard shall be given the status of a national standard at the latest by February 2018.[1]

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 under a mandate given to CEN by the European Commission, called 'recast EPBD' standards or just EPB standards. These standards have a new common format: two documents for each standardized item, a true standard EN xxxx and a supporting technical report CEN/TR xxxx. The former reports a set of normative rules, while, the latter explains how to apply the related EN standard and gives informative additional rules and data. Because the EPB standards have been produced with the aim of supporting the recast EPBD and its application at national level, a certain degree of freedom in their application was a mandatory request. Thus, these standards provide a certain flexibility regarding the methods, the required

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[1] Meanwhile CENTC156WG20 works on an update of this standard. This to optimise the convergence with other EPB standard and the future TS's regarding natural and hybrid ventilation systems (see article in RJ 2018-01). This update may also include a better aligning with the filter standards and ErP standards on ventilators.
The purpose of this revision is to consider further developments in the framework for this standard
– Revision of filtration aspects considering ISO 16890 in particular: (Chapter 9.7 and Annex a 4.2. and B.4.2.)
– Possible conflict between FprEN 16798-3 and EN 15287-1 (which might have consequences TR 16798-4)
– Check of mandatory requirements on conflicts with national EPBD requirements (including the recast version of 2018), relevant for Annex A and B and the clearly split between EPBD and general design aspects)
– Editorial improvements.
– Links in to new work on natural ventilation shall be clarified (including TR 16798-4 if needed).
– Aspects considering climate change in particular the design temperatures for ventilation and cooling (Chapter 8).
– Clarification regarding ongoing work on EN 13053 and EN 308.
– Check possibilities to add informative (non EPBD related) Annexes based on TR 16798-4 information.

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. The normative annex A is just an empty format that has to be filled at the national level to customize the standard in a way of complying to national legal requirements.

Nevertheless, the main goal of this standard is the energy performance of ventilation systems, EN 16798-3 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. It focuses on the system-aspects for typical applications and covers the following:

- Important aspects 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.

Changes respect to EN 13779

The new EN 16798-3:2017, and its supporting technical report: CEN/TR 16798-4:2017, is just the revision of EN 13779:2007, which covers exactly the same items; this revision concerns mainly the following aspects:

- The document was split in a normative part, containing all the normative aspects and a supplementary technical report containing additional information and informative annexes, i.e. CEN/TR 16798-4:2017;
- The standard allows a normative national annex;
- New structure to clarify designing and calculation aspects;
- 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 and reference is made to prEN 16798-1:2015, supply air quality have been introduced;
- Update of definitions of systems;
- Update of SFP definitions and links to EU 327/2014 regulation;
- Update of heat recovery aspects;
- Update of filtration aspects;
- Update of leakages aspects;
- Aspects of energy performance have been updated;
- The standard was supposed to be updated to cover hourly/monthly/seasonal time-step, but this is not really done.

Coordination with prEN 16798-1:2015

Apparently, the major issue related to this review is the "clear coordination with prEN 16798-1:2015", the revision of the EN 15251:2017 dealing with indoor environmental input parameters didn't pass the formal vote and is under editorial revision (i.e. not yet available)[2]. Thus, the default standard outdoor air volume flows, not any more included in the EN 16798-3:2017, are not defined until the revised prEN 16798:2015 will become a standard (probably after summer 2018). Of course, this could not be a problem if we recall the sentence reported in the superseded EN 13779:2007 at paragraph 7.4.1, "*The design shall be based whenever possible on the real data for the project*". But, "*However, if no values are declared, the default values given in Table 12 shall be applied.*" That means that we have a lack of standardized information only when the standard is used for design purposes, while, when assessing the energy performance flow rate, design values should be already defined and available, i.e. declared. Anyhow, some information can be taken from the still in force EN 15251:2007, informative Annex B, until the revised prEN 16798-1:2015 will be approved and published.

What has been lost in this revision is the basic classification of the indoor air quality (from IDA 1 to IDA 4, table 5 of EN 13779:2007). This is not included in the prEN 16798-1:2015, while, in all table dealing with indoor air quality, both in normative and informative annexes, the flow rates are referred to undefined I, II, III and IV classes. Hopefully, its revision can include this lost definition.

Actually, the major issue is the delay on the approval of the prEN 16798-1:2015 itself, because this standard defines the target parameters for designing a high quality indoor environmental building, other than for assessing its yearly energy performance. This affects not only some input to EN 16798-3:2017 but to the whole EPB package of standards. Again, this delay can be fruitful used to improve that standard, which does not clearly define how the quality class of each aspect of the indoor environment (thermal, air quality, humidity, acoustics and lighting) is weighted or not to define the IEQ (Indoor Environmental Quality) class of the building. In addition, some indoor environmental aspects are qualified with three classes, some with four classes, and again no rules are given how to combine them to obtain the IEQ class.

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2 It is expected that the second formal vote on FprEN16798-1 is expected around May 2018.

Update of definitions of systems

In the 16798-3:2017 the ventilation system paragraph has been improved including definitions for basic system types of ventilation systems (**Table 1**) as unidirectional ventilation system (UVU), bidirectional ventilation systems (BVU), natural ventilation system and hybrid ventilation systems.

The EN 13779:2007 "pressure conditions in the room" paragraph is now more clearly renamed as "design air flow balance" and explicitly refers to balanced mechanical ventilation system (BUV type), where the extract airflow rate is given as function of the supply airflow rate and the air balance class needed.

Another comprehensive table (**Table 2**) is added to classify ventilation or air-conditioning systems based on ventilation and thermal functions.

A clear definition of cooling is also given as "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)".

Table 1. 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 utilization of natural driving forces	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

Table 2. Types of Ventilation-, Air-conditioning-, and Room Conditioning-Systems based on functions.

System 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.	**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	-	-

Update of SFP definitions

The specific fan power classification has been extended respect to EN 13779:2007 adding a SPF 0 category for less than 300 $W/(m^3/s)$) and its definition is now clearly stated through a formula:

$$P_{SFP} = \frac{P}{q_v} = \frac{\Delta p_{tot}}{\eta_{tot}} = \frac{\Delta p_{stat}}{\eta_{stat}} \quad \left[\frac{\mathrm{W}}{\mathrm{m}^3/\mathrm{s}}\right]$$

(for the meaning of the symbols refer to the standard).

Paragraphs have been added to give as normative formulas and calculation methodologies for calculating:

- the power demand of the fan;
- Specific Fan Power of an entire building;
- Specific Fan Power of Individual Air Handling Units (I-AHU);
- AHU related PSFP values.

Similar formulas and calculation methodologies were also reported in the superseded EN 13779-2007, but only as informative options in the informative Annex D.

Update of heat recovery aspects

The heat recovery paragraph has been completely rewritten, updated and extended. The "dry" recovery efficiency has been introduced, as stated in EN 308 and EN 13053, but, unfortunately, a wrong symbol has been used: Φ_t instead of η_t. Some information is then reported on transfer of humidity, icing and defrosting, transfer of pollutants.

Update of filtration aspects

The filtration paragraph[3] is entirely new and gives guidance in filters selection. In fact, depending on outdoor particle pollution level and desired supply air quality, different levels of filtration are required. 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. Tables are given to define the minimum required filtration efficiency according to the selected outdoor air (ODA) quality and the supply air (SUP) class (**Table 3**) and to indicate when optional gas filtration is recommended or required (**Table 4**).

[3] All specifications are based on EN 779 which currently is replaced by ISO 16890. The ongoing review on EN 16798-3 will revise this paragraph keeping the basic principle.

Table 3. 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.

Table 4. Application of gas filter as complement to particle filtration based on gaseous outdoor air quality,

Outdoor air quality	Supply air class				
	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.

The formula to calculate the combined filtration efficiency when different filters are used in series is given as:

$$E_t = 100 \cdot \left(1 - \left(\left(1 - \frac{E_{s,1}}{100}\right) \cdot \left(1 - \frac{E_{s,2}}{100}\right) \cdot \ldots \cdot \left(1 - \frac{E_{s,n+1}}{100}\right)\right)\right)$$

where

E_t is the total filter efficiency

$E_{s,j}$ is the efficiency of each j filter step

Update of leakages aspects

The leakages in ventilation system paragraph is completely new. This paragraph was added because leakages of the air distribution or the AHU casing affect energy efficiency and function, as well as hygiene aspects (e.g. condensation). Thus, it is important to minimize leakages.

This paragraph specifically deals with leakages in heat recovery section (HRS) (internal leakages), leakages of the AHU casing (external leakages) and leakages of the air distribution (ducts) including components.

For leakages in heat recovery section, two new quantities are defined to quantify them:

- Exhaust Air Transfer ratio (EATR) [%]: ratio of the supply air mass flow rate leaving the HRS originated by air internal recirculation due to HRS internal leakages and the supply air mass flow rate leaving the HRS;
- Outdoor Air Correction Factor (OACF) [-]: ratio of the entering supply mass airflow rate and the leaving supply mass airflow rate.

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

Based on the OAC Factor a classification is given as reported in **Table 5**.

Table 5. Classification of outdoor air correction factor – Internal leakages.

	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	1,01	0,90
5	Not classified	

For leakages of the AHU casing, reference is made to EN 1886:2007 - Ventilation for buildings. Air handling units. Mechanical performance, which specifies test methods, test requirements and classifications for air handling units.

For leakages of the air distribution, ducts mainly, a classification is given based on EN 12599 - Ventilation for buildings - Test procedures and measurement methods to hand over air conditioning and ventilation systems, as reported in **Table 6**.

Table 6. 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	$0{,}00033 \times p_t^{0{,}65} \times 10^{-3}$

Some information on system air tightness was given also in the superseded EN 13779-2007, but only as informative option in the informative Annex A.

Update of energy performance aspects

The calculation and energy rating paragraph deals with the air volume flows calculations, which was partially included in EN 13779:2007 in the supply airflow rate section, and a new part devoted to the energy rating of the ventilation systems.

The major update to the air volume flows calculations is the explicit introduction of the ventilation effectiveness, ϵ_V, when calculating the ventilation air volume flow (i.e. outdoor air flow to dilute indoor contaminants) starting from normalized standard requirements as in the referred prEN 16798-1:2015.

Another update is the calculation of the required ventilation rate for humidifying or dehumidifying, if such services are provided by the ventilation systems.

What is not reported is a procedure or a criterion for selecting the effective supply airflow rate, when the ventilation air volume flow, the air volume flow required for balancing heating and cooling loads and, eventually, required ventilation rate for humidifying or dehumidifying have to be contemporary or not satisfied.

The new paragraph is on the energy rating of ventilation system, which starts with a wrong internal reference to sub-paragraph 8.8.2 to 8.8.4 (which is a typo, they do not exist and should be 9.8.2 and 9.8.4; the same in clause 10.3.2 where the references should be 9.5.4 and 9.5.6); while probably, that should be just points 3, 4, 5 and 11 of 8.8 and 8.9 paragraph. The new quantities herewith introduced, but already defined in the EN 13053 standard in a bit different way (in terms of powers instead of annual energies), are:

- Annual heat recovery efficiency,

$$\eta_e = 1 - \frac{Q_{H;V;in;req}}{Q_{H;V;tot}}$$

- Annual coefficient of performance

$$\varepsilon_{HRS} = \frac{Q_{hr}}{E_{V;hr;gen;in;el}}$$

where

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

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

Q_{hr} is *annual* heat transferred by heat recovery, in kWh

$E_{V;hr;gen,in;el}$ is *annual* electric energy of the heat recovery section required by fans and auxiliaries, in kWh.

It should be noted that a wrong symbol is used in the standard for the heat recovery efficiency compared to the EN 13053 symbols (ε_{SUP} instead of η_e) and wrong unit symbol and in the wrong position appears in the Q_{hr} and $E_{V;hr;gen;in;el}$ explanation (kW instead of kWh). In addition, the annual attribute is lost in such explanations.

Finally, a section is added that deals with primary energy use of ventilation in kWh/(m³/h)/a. A formula to calculate this primary energy use is given but it is useless because of some undefined and unreferenced terms (see below).

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

where

$f_{P,E}$, $f_{P,H}$, $f_{P,C}$, and $f_{P,HU}$, are primary energy factors, respectively, for electricity, heating, cooling and humidification; ($E_V + W_{V,aux} + W_{HU,aux}$), Q_H, ($Q_C + Q_{DH}$) and E_{HU} the related energies required as input to the air handling unit, and f_H, f_C, and f_{HU} are reported to be “delivered energy factor for” respectively heat, cold and humidification “(taking into consideration distribution and generation). Such factors are not defined in any place of the standard and there is no reference to any other standards where their definition can be found. It is opinion of the authors that such delivered energy factor has the meaning of ratio of required energy carrier delivered to the building for such service (Heating, Cooling, and Humidification) and the required energy input to the AHU for the same service. With this definition it automatically accounts for distribution and generation losses, as mentioned in the description.

Is it able to cover hourly/monthly/seasonal time-step as declared?

In the European Foreword to these standards is mentioned that "*the standard was updated to cover hourly/monthly/seasonal time-step*". Instead, there is no mention of this update or possibility that the energy performance parameters are defined on annual basis. Nevertheless, this standard is useful as it is because its main goal is to define design flow rates complying with ventilation, heating, cooling and humidification requirements and to size the ventilation unit or AHU ventilation section according to the design requirements. The energy performance calculation is instead carried out, taking into consideration different calculation time step, in other standards like EN 16798-5-1:2017 or EN 16798-5-2:2017.

Supporting technical report, CEN/TR 16798-4:2017

The technical report, CEN/TR 16798-4:2017, is the supporting report of EN 16798-3:2017. As stated at the beginning, the technical report includes additional non-normative information and application examples.

In this case, almost all the materials included in the superseded EN 13779:2007 as informative appendixes have been moved to this reports, updated and expanded. ■

References

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