

Calculation of the energy performance of ventilation and cooling systems, update of several parts in the EN 16798 family



GERHARD ZWEIFEL
Professor, Lucerne University of Applied sciences and Arts, Lucerne School of Engineering and Architecture
Convenor CEN TC 156/WG21
Gerhard.zweifel@hslu.ch

This article gives a short summary of the main issues resolved in these new standards currently out for formal vote. More details can also be found the article published in the REHVA Journal May 2016.

EN 16798-5-1

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 (revision of EN 15241) — method 1” is one of two standards, which is intended to cover a number of modules in the areas of distribution, i.e. the duct system, and “generation”, which for the ventilation and air conditioning service, is meant to be the air handling unit (AHU), including humidification and dehumidification. Part 5-1 describes a detailed method for ventilation and air conditioning systems and uses an hourly calculation step. It is a comprehensive calculation of all aspects of AC systems.

The distribution part includes the calculation of duct heat losses and duct leakage, both linked to the zones crossed and/or served by the system.

The “generation” (AHU) includes the ordinary air treatment steps for heating, cooling dehumidification and humidification.

This standard has many options to be chosen, many of them being control options with a link to the building automation (see the CEN/TC 247 standards), especially the revised EN 15232-1, which has been updated to reflect these options:

- Different air flow control types: Depending on the calculation of the required air flow rates on zone level, which is covered in EN 16798-7, the ventilation “emission” standard, the flow rate in the AHU can be controlled to be constant, multi stage or variable.
- Supply air temperature and humidity control types: constant, outdoor air compensated or load compensated.

As in reality, not all combinations are possible: only one of the two (air flow or temperature) can be load dependent.

- Fan control: the fans can be controlled differently to react on the flow control. A direct link is only possible for single zone systems (e.g. serving cinema theaters or auditoria). For multi zone systems, the flow control is usually done on zone level (e.g. by VAV boxes), and the central fan is controlled e.g. pressure dependent. Based on an input from CEN/TC 247, there are several options considering the type of pressure measurement. Experience showed that this has a big impact on the fan energy use and was too optimistic in the preceding standard EN 15241 (which will be withdrawn).
- The fan energy calculation is linked to inputs from product standards (on fans, from WG 17 in TC 156)

The standard covers different types of heat recovery:

- Plate;
- Rotary, with different types of coatings (hygroscopic, non-hygroscopic, absorptive), including humidity recovery.
- Pumped circuit.

For the calculation there is a connection to product standards (EN 308, 13053), and it includes the aspects of

- Control;
- Different ways of frost protection;
- Auxiliary energy consumption.

As the calculation of rotary heat exchangers with the humidity recovery and the auxiliary energy calculation involves a lot of input data, which users may not be familiar with, a part of the calculation was transferred to an informative annex, leaving a generic function to be defined nationally in the normative part. The annex is referred to for the “CEN option” in Annex B.

Further options are

- Recirculation control;
- Humidifier types (adiabatic or steam, involving different energy carriers), with different controls.

The method covers also a couple of special innovative solutions:

- Ground preheating / -cooling, which is described in an informative annex
- Adiabatic cooling by humidification of extract air and heat recovery.

The accompanying TR CEN/TR 16798-6 is a common document for this standard EN 16798-5-1 and the EN 16798-5-2. It gives explanations for the background of different options and choices. It shows also example ways of zoning.

The spreadsheet is fully functional and has a drop down menu structure to choose all the options¹.

EN 16798-5-2

EN 16798-5-2 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” and is the revision of EN 15241:2007. The revision of EN 15241:2007 includes the division into two parts:

- EN 16798-5-1 (covers complete range of air-conditioning system)
- prEN 16798-5-2 (covers ventilation systems for residential buildings)

EN 16798-5-2 covers energy performance calculation of mechanical ventilation systems with integrated heating/cooling generation, including domestic hot water production, using a monthly or seasonal calculation

interval or a bin method. It takes into account the generation (air handling unit) and distribution (duct system) parts. It does not cover the emission part (calculation of the required volume flow rates and/or supply air conditions), which is covered in the M5-5 standard. It does not include humidification and dehumidification. This method is focussed on small, packaged ventilation systems, typically used in residential buildings, although the application is not restricted on the basis of building or space use type.

Other changes compared to EN 15241:2007 are:

- inclusion of ventilation systems for residential buildings (including heating and cooling of air)
- improved calculation of fan energy taking into account new control strategies of TC 247 and product standard regarding fans
- improved calculation of heat recovery plants in consideration of efficiency and auxiliary energy depending on control

More information is provided in the Technical Report accompanying this standard (CEN/TR 16798-6), including examples aiming to check the quality and usability of the standard.

A calculation method for mechanical ventilation and air conditioning systems, including humidification and dehumidification, using an hourly calculation interval or a bin method, is provided in a separate standard EN 16798-5-1.

EN 16798-9

EN 16798-9:2016 “Energy performance of buildings – Part 09: Ventilation for buildings – Module M4-1, M4-4, M4-9 – Calculation methods for energy requirements of cooling systems – General” is the core of the cooling related calculation standards, the “general” part. It is supposed to be the revision of the current EN 15243:2007. However, not much of the content of the latter remained in this new standard. Some parts were moved to other standards (such as the cooling load related issues to EN ISO 52016-1 or the generation related information, as far as normative, to EN 16798-13). A big part of the content was in informative annexes, and some remaining part of this was moved to the accompanying CEN TR 16798-10.

Similar to the EN 15316-1, the general part of the heating and DHW calculation standards, this EN 16798 part 9 connects the calculation pieces of the other standards for emission, distribution, storage and generation to a complete system, considering the flow rate and tempera-

¹ The excel files are publicly available via link:
<https://isolutions.iso.org/ecom/public/nen/Livelihood/open/35102456>

ture control of the distribution branches and the load dispatching in case of insufficient energy supplied by the generation system. It follows (as the other parts do) the principle, that a subsequent energy using module reports the required energy supply to the delivering module per calculation interval, and this in turn reports the energy really delivered, based on its operational conditions, back to the using module per calculation interval.

A schematic representation is given in the standard, illustrating the boundaries of the involved modules and the nomenclature used in the detailed calculation method of the standard. The (non-exhaustive) system shown in this scheme, with a generation, a storage and two distribution branches, each serving two thermal zones and one air handling unit, is exactly represented in the spreadsheet going along with the standard. In this spreadsheet, a full annual data set of hourly values is implemented to test the calculation. An hourly calculation interval is needed for this detailed calculation method.

For the water based emission and distribution calculations (modules M4-5 and M4-6) it refers to the TC 228 heating system standards (EN 15316-2 and 3). For the storage calculation it refers to EN 16798-15 and for the generation to EN 16798-13.

In the simplified calculation method, which can also be applied to a monthly calculation interval, the distribution is covered by simply applying factors to the heat extracted from the zones and AHU's. Also, a storage calculation is not applicable. This method also addresses direct expansion (DX) systems, in which case the calculation becomes generally simpler. The emission can be zone based or via air systems. Schematic representations are given in the accompanying CEN/TR 16798-10.

A separate spreadsheet was developed for this simplified calculation method.

The standard also covers module M4-4 with two partial performance indicator proposals for cooling systems.

In the accompanying technical report CEN/TR 16798-10, examples are given for the simplified and detailed calculation methods, where the spreadsheets are provided for. This includes also an example with a whole set of linked spreadsheets for the setup shown in figure 3 of the standard. According to the number of zones, AHUs and distribution branches, there are multiple instances of several of the spreadsheets. With this setup, the functionality of the whole set of calculations in the cooling area can be demonstrated.

An issue of importance repeatedly mentioned by stakeholders is ventilative cooling, i.e. cooling by enhanced natural and/or mechanically assisted ventilation. This cannot be covered by one standard, since it involves the thermal zone calculation as well as flow rate calculations and control issues. Therefore, a description of the necessary procedure, the modules involved and the information flow is given in the accompanying TR.

EN 16798-13:2016

EN 16798-13:2016 "Energy performance of buildings – Part 13: Module M4-8 – Calculation of cooling systems – Generation" is a new standard for the cooling generation calculation, which was until now covered only in an informative annex of EN 15243:2007. It contains 2 Methods:

- Method A for an hourly calculation step;
- Method B for a monthly calculation step.

The technologies covered in both methods are

- Compression and absorption chillers;
- Place holder for "other" type of generator, being used for direct use of boreholes, ground or surface water;
- Multiple generators handling;
- "Free cooling" control option, i.e. direct cooling via heat rejection device
- Different heat rejection types:
 - Air cooled condensers;
 - Dry, wet and hybrid heat recovery devices;
 - Control options for the heat rejection (e.g. switch between dry and wet operation for hybrid heat rejectors);

In method A, there is a connection to product standards for compression chillers: A performance map is used, which is generated on the base of the measurement points from EN 14511 tests, which are used in EN 14825 for the calculation of the SEER. For additional flexibility, the method has been extended to include the case relying only on the nominal EER according to EN 14511, or, if even this is missing, a default nominal EER value. The approach for this case is a constant exergetics efficiency. This was needed because it is not mandatory for the suppliers to provide the EN 14825 based SEER and the related EER values before 2018, and therefore it cannot be expected to get these values in all cases.

An accompanying CEN TR 16798-14 and two separate spreadsheets for the two methods are available for this standard. ■