SLOVENSKI STANDARD
SIST-TP CEN/TR 16798-14:2018

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Nadomešča:
SIST EN 15243:2007

Energijske lastnosti stavb - Prezračevanje stavb - 14. del: Razlaga in utemeljitev EN 16798-13 - Izračun za hladilne sisteme - Modul M4-8 - Proizvodnja

Energy performance of buildings - Ventilation for buildings - Part 14: Interpretation of the requirements in EN 16798-13 - Calculation of cooling systems (Module M4-8) - Generation

Energieeffizienz von Gebäuden - Lüftung von Gebäuden - Teil 14: Interpretation der Anforderungen der EN 16798-13 - Berechnung von Kühlsystemen (Modul M4-8) - Erzeugung

Performance énergétique des bâtiments - Ventilation des bâtiments - Partie 14 : Interprétation des exigences de l'EN 16798-13 - Calcul des systèmes de refroidissement (Module M4-8) - Génération

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91.140.30	Prezračevalni in klimatski sistemi	Ventilation and air-conditioning systems

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Energy performance of buildings - Ventilation for buildings - Part 14: Interpretation of the requirements in EN 16798-13 - Calculation of cooling systems (Module M4-8) - Generation

Energieeffizienz von Gebäuden - Lüftung von Gebäuden - Teil 14: Interpretation der Anforderungen der EN 16798-13 - Berechnung von Kühlsystemen (Modul M4-8) - Erzeugung

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (CEN/TR 16798-14:2017) has been prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”, the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 15243:2007.

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

The necessary editorial revisions were made to comply with the requirements for each EPB Technical Report.

This document 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”.

For the convenience of Standards users CEN/TC 156, together with responsible Working Group Convenors, 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 – Ventilation for 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)
N/A	CEN/TR 16798-2	Energy performance of buildings – Ventilation for buildings – Part 2: Interpretation of the requirements in EN 16798-1 – 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 13779	EN 16798-3	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)
N/A	CEN/TR 16798-4	Energy performance of buildings – Ventilation for buildings – Part 4: Interpretation of the requirements in EN 16798- 3 – For non-residential buildings – Performance requirements for ventilation and room-conditioning systems (Modules M5-1, M5-4)

EN 15241	EN 16798-5-1	Energy performance of buildings – Ventilation for buildings – Part 5-1: Calculation methods for energy requirements of ventilation and air conditioning systems (Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8) – Method 1: Distribution and generation
EN 15241	EN 16798-5-2	Energy performance of buildings – Ventilation for buildings – Part 5-2: Calculation methods for energy requirements of ventilation systems (Modules M5-6.2, M5-8.2) – Method 2: Distribution and generation
N/A	CEN/TR 16798-6	Energy performance of buildings – Ventilation for buildings – Part 6: Interpretation of the requirements in EN 16798-5–1 and EN 16798-5-2 – Calculation methods for energy requirements of ventilation and air conditioning systems (Modules M5-6, M5-8, M 6-5, M6-8 , M7-5, M7-8)
EN 15242	EN 16798-7	Energy performance of buildings – Ventilation for buildings – Part 7: Calculation methods for the determination of air flow rates in buildings including infiltration (Module M5-5)
N/A	CEN/TR 16798-8	Energy performance of buildings – Ventilation for buildings – Part 8: Interpretation of the requirements in EN 16798-7 – Calculation methods for the determination of air flow rates in buildings including infiltration – (Module M5-5)
EN 15243	EN 16798-9	Energy performance of buildings – Ventilation for buildings – Part 9: Calculation methods for energy requirements of cooling systems (Modules M4-1, M4-4, M4-9) – General
N/A	CEN/TR 16798-10	Energy performance of buildings – Ventilation for buildings – Part 10: Interpretation of the requirements in EN 16798-9 – Calculation methods for energy requirements of cooling systems (Module M4-1,M4-4, M4-9) – General
EN 15243	EN 16798-13	Energy performance of buildings – Ventilation for buildings – Part 13: Calculation of cooling systems (Module M4-8) – Generation
EN 15243	CEN/TR 16798-14	Energy performance of buildings – Ventilation for buildings – Part 14: Interpretation of the requirements in EN 16798-13 – Calculation of cooling systems (Module M4-8) – Generation
N/A	EN 16798-15	Energy performance of buildings – Ventilation for buildings – Part 15: Calculation of cooling systems (Module M4-7) – Storage

N/A	CEN/TR 16798-16	Energy performance of buildings – Ventilation for buildings – Part 16: Interpretation of the requirements in EN 16798-15 – Calculation of cooling systems (Module M4-7) – Storage
EN 15239 and EN 15240	EN 16798-17	Energy performance of buildings – Ventilation for buildings – Part 17: Guidelines for inspection of ventilation and air-conditioning systems (Module M4-11, M5-11, M6-11, M7-11)
N/A	CEN/TR 16798-18	Energy performance of buildings – Ventilation for buildings – Part 18: Interpretation of the requirements in EN 16798-17 – Guidelines for inspection of ventilation and air-conditioning systems (Module M4-11, M5-11, M6-11, M7-11)

Introduction

The set of EPB standards, Technical Reports and supporting tools

In order to facilitate the necessary overall consistency and coherence, in terminology, approach, input/output relations and formats, for the whole set of EPB-standards, the following documents and tools are available:

a) a document with basic principles to be followed in drafting EPB-standards: CEN/TS 16628, *Energy Performance of Buildings — Basic Principles for the set of EPB standards* [1];

b) a document with detailed technical rules to be followed in drafting EPB-standards; CEN/TS 16629, *Energy Performance of Buildings — Detailed Technical Rules for the set of EPB-standards* [2]; and

c) the detailed technical rules are the basis for the following tools:

   1) a common template for each EPB-standard, including specific drafting instructions for the relevant clauses,

   2) a common template for each technical report that accompanies an EPB standard or a cluster of EPB standards, including specific drafting instructions for the relevant clauses, and

   3) a common template for the spreadsheet that accompanies each EPB standard, to demonstrate the correctness of the EPB calculation procedures.

Each EPB-standard follows the basic principles and the detailed technical rules and relates to the overarching EPB-standard, EN ISO 52000-1 [3].

One of the main purposes of the revision of the EPB-standards is to enable that laws and regulations directly refer to the EPB-standards and make compliance with them compulsory. This requires that the set of EPB-standards consists of a systematic, clear, comprehensive and unambiguous set of energy performance procedures. The number of options provided is kept as low as possible, taking into account national and regional differences in climate, culture and building tradition, policy and legal frameworks (subsidiarity principle). For each option, an informative default option is provided (Annex B).

Rationale behind the EPB Technical Reports

There is a risk that the purpose and limitations of the EPB standards will be misunderstood, unless the background and context to their contents – and the thinking behind them – is explained in some detail to readers of the standards. Consequently, various types of informative contents are recorded and made available for users to properly understand, apply and nationally or regionally implement the EPB standards.

If this explanation would have been attempted in the standards themselves, the result is likely to be confusing and cumbersome, especially if the standards are implemented or referenced in national or regional building codes.

Therefore each EPB standard is accompanied by an informative technical report, like this one, where all informative content is collected, to ensure a clear separation between normative and informative contents (see CEN/TS 16629 [2]):

— to avoid flooding and confusing the actual normative part with informative content;

— to reduce the page count of the actual standard; and

— to facilitate understanding of the set of EPB standards.

This was also one of the main recommendations from the European CENSE project [5] that laid the foundation for the preparation of the set of EPB standards.

This Technical Report

This Technical Report accompanies the suite of EPB standards on ventilation for buildings. It relates to the European standard EN 16798-13, which forms part of a set of standards related to the evaluation of the energy performance of buildings (EPB).

The role and the positioning of the accompanied standard in the set of EPB standards is defined in the Introduction to the standard.

Accompanying spreadsheets

Concerning the accompanied standard EN 16798-13, the following spreadsheets were produced:

— EN 16798-13, Method A;

— EN 16798-13, Method B, example 1; and

— EN 16798-13, Method B, example 2.

In this Technical Report, examples of each of these calculation sheets are included.

1 Scope

This Technical Report refers to the standard EN 16798-13.

It contains information to support the correct understanding and use of this standard.

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.

NOTE More information on the use of EPB module numbers for normative references between EPB standards is given in CEN ISO/TR 52000-2.

EN 14511 (all parts), *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling*

EN 14825, *Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance*

EN 16798-13, *Energy performance of buildings — Part 13: Module M4-8 — Calculation of cooling systems — Generation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16798-13 apply.

NOTE More information on some key EPB terms and definitions is given in CEN ISO/TR 52000-2.

4 Symbols, subscripts and abbreviations

For the purposes of this document, the symbols, subscripts and abbreviations as mentioned and given in the accompanied EPB standard, EN 16798-13, apply.

More information on key EPB symbols is given in CEN ISO/TR 52000-2.

5 Brief description of the methods and routing

5.1 Output of the method

No additional information beyond the accompanied standard.

5.2 General description of the methods

5.2.1 Method A

The method is designed for an hourly calculation, based on the operational conditions and system design possibilities. It covers the cooling generator calculation including multiple generators, the heat rejection devices and its control, and includes the possibility of “free cooling” in form of bypassing the generator and using the heat rejection device directly when the climate conditions allow for. Also, heat to be rejected is offered as a potential heat to be recovered on the heating/domestic hot water side.

Three different generator types are distinguished: compression chillers, absorption chillers and a "generic" type labelled "OTHER", to cover e.g. the direct use of heat sinks like ground (boreholes), ground water or surface water.

Three approaches are offered to calculate the compression chiller characteristics:

— characteristics based on EN 14825 values;

— characteristics based on one nominal EER (EN 14511 (all parts)); and

— unknown performance data.

For the heat rejection, dry, wet and mixed mode (hybrid) heat rejecters are covered as well as the use of other heat sinks as ground, ground water or surface water, in association with the respective control options.

5.2.2 Method B

The method is designed for an hourly or monthly calculation, based on the operational conditions and system design possibilities. It covers the cooling generator calculation including the heat rejection and includes the possibility of "free cooling" in form of bypassing the generator and using the heat rejection device directly when the climate conditions allow for. Also, heat to be rejected is offered as a potential heat to be recovered on the heating/domestic hot water side.

Two different generator types are distinguished: compression chillers, absorption chillers. Moreover, direct-evaporating room air-conditioning systems are also applicable. See Method A for other systems, such as, the direct use of heat sinks like ground (boreholes), ground water or surface water. Tabulated or measured part-load data should be employed for the evaluation of the part-load behaviour.

For the heat rejection, dry, wet and mixed mode (hybrid) heat rejecters are covered.

The calculation includes the operation and control of multi generator set ups.

5.3 Selection criteria between the methods

The criteria for method selection are summarized in Table 1.

Table 1 — Criteria for method selection

Criterion	**Method A**	**Method B**
System status		
Existing cooling generation system	x	x
New cooling generation system	x	x
Availability of data		
Detailed part-load data according to EN 14825 available	x	
Detailed part-load data according to EN 14825 not available	x	x
System type		
Compression or absorption chiller systems	x	x
Multi-split room air conditioning systems		x
Other heat sinks (e.g. ground source heat exchanger, aquifer,)	x	
Calculation interval		
Hourly	x	x
Monthly		x
Bin method	x	
Climatic data/pre calculated factors		
Factors in compliance with climate or calculated		x
Factors not in compliance with climate or not calculated	x	

6 Calculation method - Method A

6.1 Output data

No additional information beyond the accompanied standard.

6.2 Calculation time interval and calculation period

The method is designed for an hourly calculation interval.

Applications to any other calculation intervals and bins add complexity. An application in a bin method structure is possible, if the load distribution to the temperature bins can be reasonably determined. An example calculation for this, originating from EN 15243, is given in Annex D.

Refer to method B for longer calculation intervals.

6.3 Input data

6.3.1 Source of data

No additional information beyond the accompanied standard.

6.3.2 Product data — Product technical data

6.3.2.1 General

No additional information beyond the accompanied standard.

6.3.2.2 Compression chiller coefficients

6.3.2.2.1 Characteristics based on EN 14825 values

To model the characteristics based on EN 14825 values, a semi-physical/semi-empirical model (grey box) model is used, which is designed to require a minimum of input to characterize a performance map in the space of part load ratio and temperature lift. The model requires four coefficients C_1, C_2, C_3, and C_4 and a correction temperature difference $\Delta\vartheta_{corr}$. The background and testing of the model is described in [6].

The determination of these values from supplier's data are described with Formulae (1) and (2). The required supplier's data are the four values $EER_{A, B, C, D}$, used for the *SEER* calculation in EN 14825, in association with the conditions of their measurement (Table 7 in the accompanied standard). These data (but not the *SEER* value itself) are used as an input for this method.

The method to solve the equation system of Formula (1) for the five unknown variables C_1, C_2, C_3, C_4 and $\Delta\vartheta_{corr}$ is based on linear algebra, using the matrix inversion technique. It is implemented in the spreadsheet to this method of the accompanied standard (see Annex C, C.1).

Due to the unfavourable distribution of these four points for this purpose, a fifth EER_5 value at an operation point outside of the range is needed. This operational point can theoretically be freely chosen, but is preferably the 50 % part load value at temperature conditions for the full load value. However, since this value is not necessarily available, a default calculation for this is given with Formula (2). With this formula the $\Delta\vartheta_{corr}$ becomes 0.

It will be mandatory for manufacturers/suppliers as from the year 2018, to provide the SEER according to EN 14825. Therefore, it can be expected that also the data of the four operation points will be available and the method can be applied. In many cases they can be calculated with the software provided by the manufacturer, which allows the calculation of the EER at different conditions. This is even true for the 5th point.

Alternatively to this method, the performance can be described by interpolation of tabled values, if more detailed data are provided.

6.3.2.2.2 Characteristics based on one nominal EER (EN 14511 (all parts))

Since the publication of the *SEER* values is not yet mandatory at the time of the publication of the accompanied standard, an alternative calculation is offered, based on the nominal EER_n, obtained from tests according to EN 14511 (all parts). See comment to Formula (19) below for the application in the calculation.

6.3.2.2.3 Unknown performance data

In the absence of the EN 14511 test value, an EER_n value defined on a national basis following the template given in Table A.2 can be used in the same way.

6.3.2.3 Absorption chiller characteristics

For the absorption chiller characteristic, a quadratic equation is used.

6.3.2.4 Other generator characteristics

Any generator, the performance of which can be described by a performance map generated by interpolation of tabled values, can be covered in the calculation, using the generator type “OTHER”.

For generic generator types (type OTHER), a function $f_l(\vartheta_{C;gen;out} ; \vartheta_{sk;l} ; f_{C;PL;l})$ to describe the heat extraction of the generator depending on the generation outlet temperature, the sink temperature and the part load ratio, to be applied as a factor on the required cooling energy intake, is assumed. The exact form of the function is not given and should be defined for specific cases. In the simplest case, this may be a constant factor (e.g. representing a circulation pump consuming energy proportional to the required cooling generation energy intake).

6.3.3 System design data

No additional information beyond the accompanied standard.

6.3.4 Operating conditions

No additional information beyond the accompanied standard.

6.3.5 Constants and physical data

No additional information beyond the accompanied standard.

6.4 Calculation procedure

6.4.1 Applicable calculation interval

See 6.2.

6.4.2 Operating conditions calculation

The operation conditions calculation defines the operational boundary conditions for the operation of the generation systems. It includes the calculation of the condenser inlet temperature for dry and for wet operation (Formula (3); both are needed to decide on the operation in case of hybrid heat rejection devices), and of the generator outlet temperature, which is delivered by the generation system to the cooling distribution system (Formula (4)). For compression and absorption chillers the evaporator outlet temperature is set to that value (Formula (5)).

In Formula (4) the required generation outlet temperature is needed as an input value. This value is an input variable originating from the module M4-1 standard. It might be expected that the issue of controlling the generation outlet temperature, offering the options of constant or variable generation outlet temperatures, would be given here. This is, however, covered in the module M4-1 standard, because it is also involving the influence of, e.g. the storage charging/discharging operation.

Formula (6) is used to define the possibility of free cooling operation.

In Formulae (7) to (12), the operation of multiple generator settings is calculated, based on a given priority for the different chillers. The priority is assumed to be an input from the module M10-12 standard, based on information on the required energy to be extracted, the number of generators and the maximum hourly heat extraction of all generators, which is delivered as an output to that module.

In Formulae (13) and (14), the heat rejection operation is defined, depending on the heat rejection type and its control. For air cooled condensers, the heat rejection circuit is not present, and the condenser inlet temperature becomes the outdoor air temperature, if it is above the limit, which is an input parameter. For all other types, there is a circuit, which ads a temperature difference for the heat exchange and another one for the heat losses of the circuit (calculated in Formula (3)). For HYBRID heat rejection devices, there are two control options for the switch between dry and wet operation: For the TEMP option, a fixed outdoor temperature limit is used for the switch, independent of the energy to be extracted. For the MAX_POWER option, the switch is only done if the sum of all generators cannot meet the required energy to be extracted at dry conditions in the current calculation interval.