SLOVENSKI STANDARD

SIST-TP CEN/TR 15316-6-3:2018

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Energijske lastnosti stavb - Metoda za izračun energijskih zahtev in učinkovitosti sistema - 6-3. del: Razlaga in utemeljitev EN 15316-3 - Moduli M3-6, M4-6 in M8-6

Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-3: Explanation and justification of 15316-3, Module M3-6, M4-6, M8-6

Heizungsanlagen und Wasserbasierte Kühlanlagen in Gebäuden - Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen - Teil 6-3: Begleitende TR zur EN 15316-3 (Wärmeverteilungssysteme für die Raumheizung (Trinkwarmwasser, Heizen und Kühlen))

Performance énergétique des bâtiments - Méthode de calcul des besoins énergétiques et des rendements des systèmes - Partie 6-2 : Explication et justification de l’EN 15316-2, Module M3-5, M4-5

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ICS:

91.140.10	Sistemi centralnega ogrevanja	Central heating systems
91.140.65	Oprema za ogrevanje vode	Water heating equipment

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Contents

Page

European foreword

This document (CEN/TR 15316-6-3:2017) has been prepared by Technical Committee CEN/TC 228 “Heating systems and water based cooling systems in buildings”, the secretariat of which is held by DIN.

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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 16628:2014, 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 16629:2014, Energy Performance of Buildings - Detailed Technical Rules for the set of EPB-standards [2];

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;

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

Each EPB-standards 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.

1 Scope

This Technical Report refers to standard EN 15316-3, modules Space Distribution Systems Module M3-6 heating / M4-6 cooling / M8-6 domestic hot water

It contains information to support the correct understanding, use and national adaptation of standard EN 15316-3.

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 15316-3, *Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 3: Space distribution systems (DHW, heating and cooling), Module M3-6, M4-6, M8-6*

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

EN ISO 52000-1:2017, *Energy performance of buildings - Overarching EPB assessment - Part 1: General framework and procedures (ISO 52000-1:2017)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7345:1995, EN ISO 52000-1:2017 and the following apply.

3.1
tapping profile
depending on the definition in M8-3

3.2
setback
operation Mode for pumps at the end of scheduled usage time

3.3
boost
operation Mode for pumps before the begin of scheduled usage time

4 Symbols and abbreviations

4.1 Symbols

For the purposes of this Technical Report, the symbols given in EN ISO 52000-1:2017, in EN 15316-3 (the accompanied EPB standard) and the specific symbols listed in Table 1 apply.

Table 1 — Specific symbols and units

Symbol	Name of quantity	Unit
n_{Tap}	Tapping profile	1/h

4.2 Subscripts

For the purposes of this Technical Report, subscripts given in EN ISO 52000-1:2017, in EN 15316-3 and the specific subscripts listed in Table 2 apply.

Table 2 — Specific Subscripts

boost	Boost heating	dis	Distribution	$W_{X,dis,aux}$	Operation mode
setb	Setback mode	dis	Distribution	$W_{X,dis,aux}$	Operation mode
nom	nominal heat loss	dis	Distribution	$Q_{w,dis,nom}$	
stub	open circuited stubs	dis	Distribution	$Q_{W,dis,stub}$	

5 Information on the methods

The calculation of the thermal losses of pipes is well known and is used in this standard as a simplified model without any dynamic aspects like heat capacity of the pipes und changing of transfer coefficients. It is always taken into account that within a time step the heat flux from the mean water temperature in the pipe to the surrounding room is constant.

In closed circuits like for space heating and space cooling the mean supply and mean return temperature within a time step is constant.

In open circuits like in domestic hot water systems with a circulation loop the open circuited stubs the temperature drops down depending on the time after a tapping. The calculation method in this standard allows calculating the temperature after the last tapping and then a mean temperature in this period without tapping. Because of the problem that the time after a tapping is mostly not known the calculation method in this standard allows calculating the mean temperature directly as an approximation depending on the thermal linear resistance.

In domestic hot water systems without a circulation loop the thermal loss of the hot water pipes in total can be calculated like open circuited stubs either with the detailed calculation of the temperature after the last tapping or with the approximation of the mean temperature depending on the thermal linear resistance.

As long as the tapping profile only gives the number of tapping's per day it is not possible to determine the time after the last tapping. Therefore the approximation should prefer.

The calculation of the thermal resistance for insulated or not insulated pipes is well known and is given in this standard for the most relevant cases. Depending on national regulations often minimum values of thermal resistances are postulated so that in the standard values for the most relevant cases in the pipe sections are given.

The equations in the standard refer to the length of the pipes in the corresponding section of the network. If the length of the pipes is known the calculations are directly possible. In an early design stage or in existing buildings the length of pipes is not known. Therefore is a method in the standard developed where the length of pipes can be calculated depending on the size of the corresponding zone (building).

The auxiliary energy in distribution systems for space heating or space cooling corresponds to the circulation pumps. In distribution systems for domestic hot water the auxiliary energy is either the energy for the circulation pump or for a ribbon heater.

The auxiliary energy for pumps depends very much from the part load operation. Europump, the European Association of Pump Manufacturers, has established a common method to calculate the expenditure energy for distribution pumps, so that this method is used in this standard. Meanwhile a product label EEI (energy efficiency index) according to the EU regulations is available (not for all kind of pumps – only for circulation pumps (wet running meter) in the range of 1 W to 2 500 W of hydraulic power). If this EEI of a real pump is known in the standard a method is developed to take it into account.

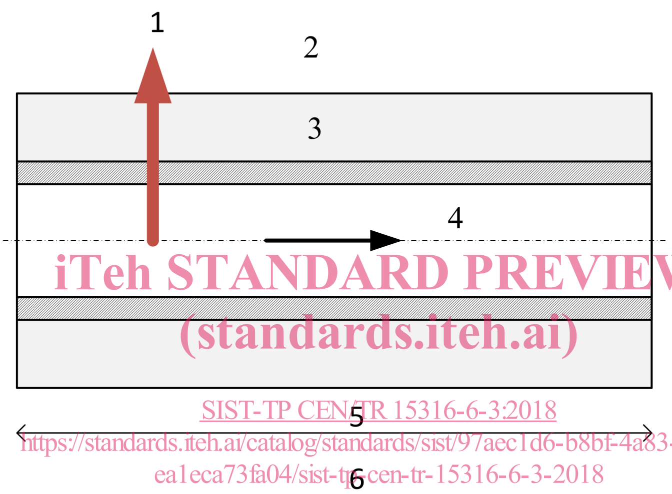
6 Method description

6.1 Thermal loss calculation and auxiliary energy in distribution systems

6.1.1 Basic principles

The input data are the actual input and output temperatures of the circuit as well as the volume flow and the part load in the time step of calculation. The increasing fluid temperature in the circuit is not calculates in this module.

The thermal loss of a pipe and the relevant values in a pipe section j are shown in Figure 1.



Key

1	$Q_{diss,ls}$	4	θ_{mean}
2	θ_{amb}	3	- Ψ
5	L	6	Pipe j

Figure 1 — Thermal loss of a pipe and relevant values

The thermal loss in a distribution system is calculated by the basic equation which for a pipe section and a time step is given by:

$$Q_{dis,ls} = \frac{1}{1000} \cdot \Psi \cdot \left(\theta_{mean} - \theta_{amb}\right) \cdot \left(L + L_{equi}\right) \cdot t_c \text{ [kWh]} \quad (1)$$

where

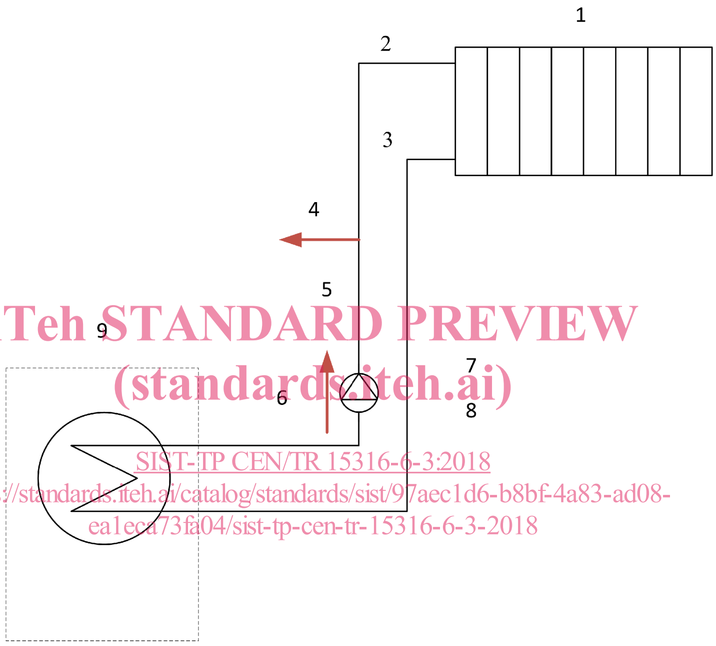
θ_{amb}	[°C]	is the surrounding temperature in the zone
L	[m]	is the length of the pipe in the zone (unconditioned or conditioned)
L_{equi}	[m]	is the equivalent Length of the pipe for valves, hangers etc. in the zone (unconditioned or conditioned)
t_c	[h]	is the time step

Ψ [W/mK] is the linear thermal resistance

In the standard the basic Formula (1) is only adapted to the different boundary conditions and also completed with the summation over the different parts of the network where the boundary conditions are constant (i.e. constant surrounding temperature, constant linear thermal resistance). Also a summation over all time steps is added.

In distribution systems with closed loops for space heating and space cooling (see Figure 2) the mean water temperature is represented by the mean value of the supply and return temperature and given by:

$$\theta_{\text{mean}} = \frac{\theta_{in} + \theta_{out}}{2} \text{ [°C]} \quad (2)$$



Key

1 Emitter
2 $\theta_{X,em,in}$
3 $\theta_{X,em,out}$
4 $Q_{X,dis,ls}$
5 L_{max}
6 $W_{X,dis,aux}$
7 Δp
8 $\dot{V}$
9 Generator / Storage Tank

Figure 2 — Distribution system for space heating or space cooling systems – closed loop (Index X for H = heating; C = cooling)

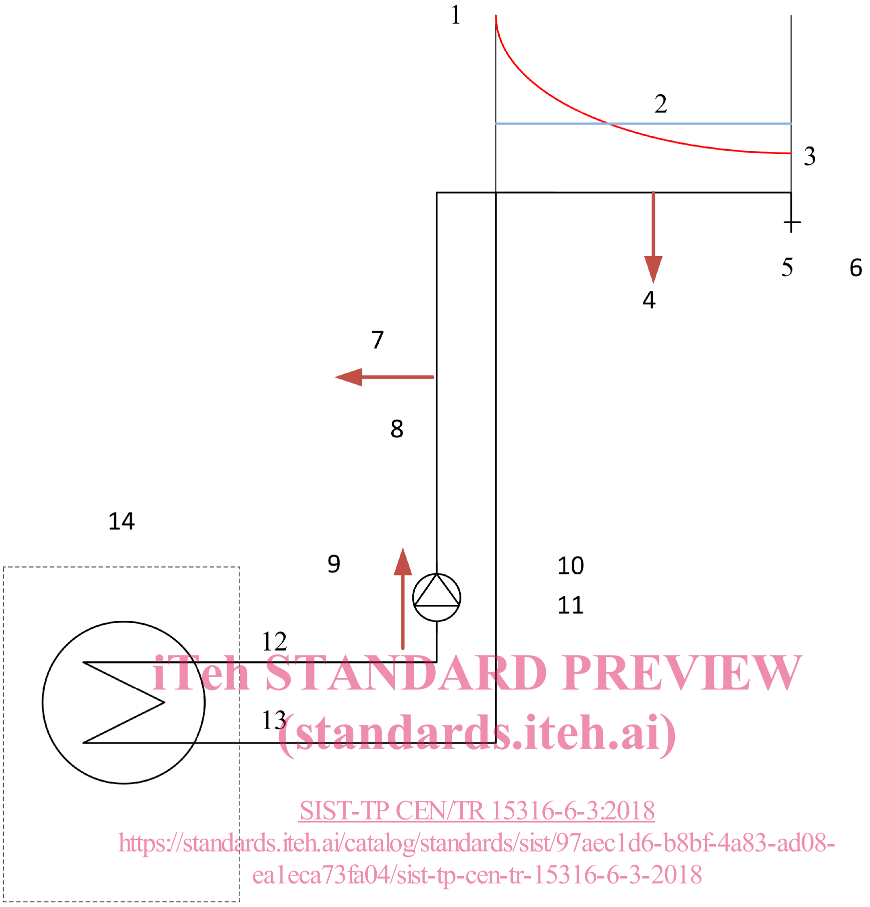
In distribution systems for DHW with a circulation loop (see Figure 3) the mean water temperature is given by:

$$\theta_{\text{mean}} = \theta_W - \frac{\Delta\theta_W}{2} \text{ [°C]} \quad (3)$$

where

θ_W [°C] is the hot water temperature

$\Delta\theta_W$ [°C] is the temperature difference between hot water tapping temperature to the return temperature in a circulation loop system



Key

1	θ_W	8	L_{max}
2	$\theta_{W,avg}$	9	$W_{W,dis,aux}$
3	$\theta_{W,atap}$	10	Δp
4	$Q_{W,dis,stub}$	11	$\dot{V}$
5	θ_W	12	θ_W
6	Tap	13	$\theta_W - \Delta\theta_W$
7	$Q_{W,diss,ls}$	14	Generator / Storage Tank

Figure 3 — Distribution system for DHW with circulation loop

The thermal loss of the circulation loop in a DHW system is similar to the distribution system for space heating or space cooling as long the circulation loop is operating. The calculation of the thermal loss in the circulation loop when the circulation is not operating is just similar. Only the mean water temperature depends on the time after the last operation of the circulation. An additional thermal loss for the open circuited stubs is given (see Figure 3) in the time when it is operating and in the time when there is no tapping because the temperature drops down depending on the time after a the last tapping.

If the number of tapping's and the volume of water within the pipes in the open circuited stubs are known the mass flow can be calculated and under the assumption that between the tapping's the hot water temperature drops down to the surrounding temperature the thermal loss can be calculated by:

The mass flow of hot water in open circuited stubs mw,dis,stub during operation is given by:

$$\dot{m}_{W,dis,stub} = \sum_j V_j \cdot \rho_W \cdot n_{tap,j} \quad \text{[kg/h]} \tag{4}$$

where

V	[m³]	is the volume of pipes in open circuited stubs per zone
ρ_W	[kg/m³]	is the density of water
$n_{tap,j}$	[1/h]	is the number of tapings per zone

The additional thermal loss for distribution pipes with open circuited stubs $Q_{W,dis,stub}$ per time step is given by:

$$Q_{W,dis,stub} = \dot{m}_{W,dis,stub} \cdot c_w \cdot \left(\theta_W - \theta_{W,amb,j}\right) \cdot t_{ci} \quad \text{[kWh]} \tag{5}$$

where

c_W	[kWh/kgK]	is the specific heat of water
$m_{W,dis,stub}$	[kg/h]	is the mass flow of hot water in open circuited stubs

If the time after the last tapping or the last circulation in circulation loops is known it is possible to calculate the temperature after the last tapping. In addition the heat capacity of the pipes and the heat flow rate per length shall be known respectively shall be calculated.

The hot water temperature after a tapping during a time without operation $\theta_{W,dis,atap}$ is given by:

$$\theta_{W,dis,atap,i} = \theta_{W,ah,j} + \left(\theta_W - \theta_{W,amb,j}\right) \cdot e^{-C_i} \quad [°C] \tag{6}$$

where

C_i	[-]	is the exponent in pipe section i (see Formula (13)

The exponent C_i for the calculation of the temperature drop after a tapping is given by:

$$C_i = \frac{q_i \cdot L_i \cdot t_{atap}}{c_W \cdot \rho_W \cdot V_i + c_p \cdot m_{p,i}} \cdot \frac{1}{\left(\theta_W - \theta_{W,amb,i}\right)} \tag{7}$$

where

V	[m³]	is the volume of pipes in section i
c_P	[kg/m³]	is the specific heat of pipe
m_P	[kg]	is the mass of pipe in section i
t_{atap}	[h]	is the time after a tapping before next tapping
q_i	[W/m]	is the heat flow rate per length (see Formula (8)

The heat flow per length is given by:

$$q_i = \Psi_i \cdot \left(\theta_W - \theta_{W,amb,j}\right) \quad \text{[W/m]} \tag{8}$$