INTERNATIONAL STANDARD

ISO

52031

First edition
2020-04

Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Space emission systems (heating and cooling)

Performance énergétique des bâtiments — Méthode de calcul des besoins énergétiques et des rendements des systèmes — Systèmes d'émission (de chaleur et de froid) dans les locaux

© ISO 2020

COPYRIGHT PROTECTED DOCUMENT

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 205, *Building environment design*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is part of a series aimed at international harmonization of the methodology for assessing the energy performance of buildings. Throughout, this series is referred to as a 'set of EPB standards'.

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

All EPB standards provide a certain flexibility with regard to the methods, the required 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.

For the correct use of this document, a normative template is given in Annex A to specify these choices. Informative default choices are provided in Annex B.

The framework for overall EPB includes:

a)   common terms, definitions and symbols;

b)   building and assessment boundaries;

c)   building partitioning into space categories;

d)   methodology for calculating the EPB (formulae on energy used, delivered, produced and/or exported at the building site and nearby);

e)   a set of overall formulae and input-output relations, linking the various elements relevant for the assessment of the overall EPB;

f)   general requirements for EPB dealing with partial calculations;

g)   rules for the combination of different spaces into zones;

h)   performance indicators;

i)   methodology for measured energy performance assessment.

The EPB series covers:

a)   energy performance calculation for heating systems;

b)   inspection of heating systems;

c)   design of heating systems;

d)   installation and commissioning of heating systems.

This document constitutes the specific part related to space heating and cooling emission, determining methods for calculation of energy losses/requirements of space heating and cooling systems, space cooling systems and domestic hot water systems in buildings.

This document specifies the structure for calculation of the additional heat and cooling losses and energy requirements of a heat and cooling emission systems for meeting the building net energy demand.

The calculation method is used for the following applications:

—   calculation of the additional energy losses in the heat emission system or cooling system;

—   optimisation of the energy performance of a planned heat emission system or cooling system, by applying the method to several possible options.

Table 1 shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

NOTE 1   In ISO/TR 52000-2 the same table can be found, with, for each module, the numbers of the relevant EPB standards and accompanying technical reports that are published or in preparation.

NOTE 2   The modules represent EPB standards, although one EPB standard can cover more than one module and one module can be covered by more than one EPB standard, for instance a simplified and a detailed method respectively. See Tables A.1 and B.1.

Table 1 — Position of this document (in casu M1-1–M1-3, M1-5, M1-7–M1-10), within the modular structure of the set of EPB standards

Overarching		Building (as such)		Technical building systems										
						Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic hot water	Lighting	Building automation and control	PV, wind...
Sub-module	Descriptions	Descriptions		Descriptions		M3	M4	M5	M6	M7	M8	M9	M10	M11
sub1	M1	sub1 (M2)	M2	sub1	Descriptions									
1	General	1	General	1	General	EN 15316-1					EN 15316-1			
2	Common terms and definitions; symbols, units and subscripts	2	Building energy needs	2	Needs						EN 12831-3			
3	Applications	3	(Free) Indoor conditions without systems	3	Maximum load and power	EN 12831-1					EN 12831-3			
4	Ways to express energy performance	4	Ways to express energy performance	4	Ways to express energy performance	EN 15316-1					EN 15316-1			
5	Building categories and building boundaries	5	Heat transfer by transmission	5	Emission and control	EN 15316-2	EN 15316-2							
6	Building occupancy and operating conditions	6	Heat transfer by infiltration and ventilation	6	Distribution and control	EN 15316-3	EN 15316-3				EN 15316-3			
7	Aggregation of energy services and energy carriers	7	Internal heat gains	7	Storage and control	EN 15316-5					EN 15316-5 EN 15316-4-3			
8	Building zoning	8	Solar heat gains	8	Generation									
				8-1	Combustion boilers	EN 15316-4-1					EN 15316-4-1			
				8-2	Heat pumps	EN 15316-4-2	EN 15316-4-2				EN 15316-4-2			
				8-3	Thermal solar Photovoltaics	EN 15316-4-3					EN 15316-4-3			EN 15316-4-3
				8-4	On-site cogeneration	EN 15316-4-4					EN 15316-4-4			EN 15316-4-4
				8-5	District heating and cooling	EN 15316-4-5	EN 15316-4-5							EN 15316-4-5

Table 1 *(continued)*

Overarching			Building (as such)		Technical building systems										
Sub-module	Descriptions	M1	sub1	Descriptions / M2	sub1	Descriptions	Heating M3	Cooling M4	Ventilation M5	Humidification M6	Dehumidification M7	Domestic hot water M8	Lighting M9	Building automation and control M10	PV, wind... M11
sub1			sub1		sub1										
					8-6	Direct electrical heater	EN 15316-4-6					EN 15316-4-6			
					8-7	Wind turbines									EN 15316-4-7
					8-8	Radiant heating, stoves	EN 15316-4-8								
9	Calculated energy performance		9	Building dynamics (thermal mass)	9	Load dispatching and operating conditions									
10	Measured energy performance		10	Measured energy performance	10	Measured energy performance	EN 15378-3					EN 15378-3			
11	Inspection		11	Inspection	11	Inspection	EN 15378-1					EN 15378-1			
12	Ways to express indoor comfort		12	—	12	BMS									
13	External environment conditions														
14	Economic calculation	15459-1													

Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Space emission systems (heating and cooling)

1 Scope

This document establishes the required inputs, outputs and links (structure) of the calculation method for heating and cooling space emission systems.

This document is applicable to the energy performance calculation of heating systems and water-based cooling space emission sub-systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7345, *Thermal performance of buildings and building components — Physical quantities and definitions*

ISO 52000-1, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
heat loss
emissions within the heating system as losses through the building envelope due to non-uniform temperature distribution, *control* (3.3) inefficiencies and losses of emitters embedded in the building structure

3.2
cooling loss
emissions within the cooling system as losses through the building envelope due to non-uniform temperature distribution, *control* (3.3) inefficiencies and losses of emitters embedded in the building structure

3.3
control
self-acting devices with and without auxiliary energy to keep a physical condition such as temperature, humidity, etc. close to set-point

3.4
emission system
system which transmits heat or cold into the room

Note 1 to entry: In different countries the word emission system is replaced by the word distribution systems.

4 Symbols and subscripts

4.1 Symbols

For the purposes of this document, the symbols given in ISO 52000-1 and the following apply.

RF   radiant factor

4.2 Subscripts

For the purposes of this document, the subscripts given in ISO 52000-1 and the following apply.

emb	embedded
fan	fan
emt	emitter
hydr	hydraulic balancing
im	intermittent
ini	initial
inc	increased
roomaut	room automation
pmp	pump
rad	radiant
str	stratification
conv	convective

5 Description of the method

5.1 Output of the method

The method described in this document calculates:

— energy losses (heating and cooling) $Q_{em,ls}$ in kWh;

— auxiliary energy: heat/cooling emission W_{em} in kWh;

— room temperature $\theta_{int,inc}$ in °C.

The time step of the output can be:

— hourly;

— monthly;

— yearly;

according to the time step of the input.

5.2 General description of the method

The energy performance is assessed by values of the increased space temperatures due to heat and cooling emission system inefficiencies.

The method is based on an analysis of the following characteristics of a space heating emission system or cooling system including control:

— non-uniform space temperature distribution;

— emitters;

— emitters embedded in the building structure;

— control accuracy of the indoor temperature;

— operation of controls/controls systems and emitters.

The energy required by the emission system is calculated separately for thermal energy and electrical energy in order to determine the final energy, and subsequently the corresponding primary energy is calculated.

For the calculation of the different characteristics within combined systems it is assumed that the system is designed under the aspect of energy optimisation.

6 Calculation method

6.1 Output data

The output data of this method are listed in Table 2.

Table 2 — Output data of this method

Description	Symbol	Unit	Validity interval	Intended	Varying
auxiliary energy — heating/cooling emission	$W_{em,ls,aux}$	kWh	$0...\infty$	M3-1	Yes
additional energy losses of heat emission	$Q_{em,ls}$	kWh	$0...\infty$	M3-1	Yes
equivalent internal heating temperature	$\theta_{H;int;inc}$	°C	$-5...40$	M3-1	Yes
equivalent internal cooling temperature	$\theta_{C;int;inc}$	°C	$-5...40$	M4-1	Yes
temperature variation based on losses	$\Delta\theta_{int;inc}$	°C	$-5...40$	M3-1	Yes
annual expenditure factor for the heat and cooling emission	$\varepsilon_{em,ls,an}$	—	$1...2$	M3-1	No
convective fraction of the heating/cooling emitter	$f_{em,conv}$	—	$0...1$	M3-1/M2-2	No

6.2 Calculation time interval

The objective of the calculation is to determine the annual energy demand or the energy demand of a time period of the space heating/cooling emission system. This may be done in one of the following two different ways:

— by using annual data for the system operation period and perform the calculations using annual average values;

— by dividing the year into a number of calculation periods (e.g. year, month, week, day, hour, boosted sub-period) and perform the calculations for each period using period dependent values and adding up the results for all the periods over the year.

6.3 Input data

6.3.1 Source of data

Input data about products that are required for the calculation described in this document shall be the data supplied by the manufacturer if they are declared according to relevant product standards.

If no such data from the manufacturer is available, or if the required data are not product data, default values are given in Annex B.

6.3.2 Product data (technical data)

The product data shall be the value declared by the manufacturer according to measurements performed meeting the requirements of the relevant product standards. If values declared by the manufacturer are not available, then default values are given in informative Annex B. New values can be definite based on the boundary condition from Annex C.

Required technical data for this calculation procedure are listed in Table 3.

Table 3 — Product technical input data list

Characteristics	Symbol	Catalogue unit	Computed unit	Validity interval	Ref.	Varying
control variation of temperature	$\Delta\theta_{ctr}$	K	K	−5...5	6.4.2	No
temperature variation based on control, not certified products	$\Delta\theta_{ctr,1}$	K	K	−5...+5	6.4.2	No
temperature variation based on control, certified products	$\Delta\theta_{ctr,2}$	K	K	−5...+5	6.4.2	No
hysteresis of thermostatic valve	θ_H	K	K	0...1	6.4.2	No
effect of supply water temperature on thermostatic controllers (TRV) head sensing element	θ_W	K	K	0...1	6.4.2	No
temperature variation based on not balanced hydraulic systems	$\Delta\theta_{hydr}$	K	K	0...1	6.4.2	No
temperature variation based on intermittent controls operation system	$\Delta\theta_{im,crt}$	K	K	−5...+5	6.4.2	No
temperature variation based on intermittent operation of the emission system	$\Delta\theta_{im,emt}$	K	K	−5...+5	6.4.2	No
temperature variation based on radiation by type of the emission system	$\Delta\theta_{rad}$	K	K	−5...+5	6.4.2	No
temperature variation based on the stratification	$\Delta\theta_{str}$	K	K	−5...+5	6.4.2	No
temperature variation based on the stratification — part of influence due to "over-temperature"	$\Delta\theta_{str,1}$	K	K	−5...+5	6.4.2	No
temperature variation based on the stratification — part of influence due to "specific heat losses via external components"	$\Delta\theta_{str,2}$	K	K	−5...+5	6.4.2	No

Table 3 *(continued)*

Characteristics	Symbol	Catalogue unit	Computed unit	Validity interval	Ref.	Varying
temperature variation based on an additional heating/cooling loss by emitters embedded in the envelope	$\Delta\theta_{emb}$	K	K	−5...+5	6.4.2	No
temperature variation based on an additional heating/cooling loss by emitters embedded in the envelope — part of influence due to the "system"	$\Delta\theta_{emb,1}$	K	K	−5...+5	6.4.2	No
temperature variation for consideration of solar and internal gains	$\Delta\theta_{e,sol}$	K	K	−15...+15	6.4.2	No
temperature variation based on an additional heating/cooling loss by emitters embedded in the envelope — part of influence due to "specific heat losses via laying surfaces"	$\Delta\theta_{emb,2}$	K	K	−5...+5	6.4.2	No
temperature variation based on room automation	$\Delta\theta_{roomaut}$	K	K	−5...+5	6.4.2	No
radiant factor of radiant heaters for room heights ≥4 m	RF			0...1	6.4.2	No
room height	h_R	m	m	2...50	6.4.2	No
electrical rated power consumption of the control	P_{ctr}	W	W	0...500	6.4.4	No
electrical rated power consumption of the equipment	$P_{H,aux}$	W	W	0...500	6.4.4	No
electrical rated power consumption of the fan	P_{fan}	W	W	0...500	6.4.4	No
design nominal useful emitter power	Φ_{Hemn}	kW	W	0...		No

6.3.3   Configuration and system design data

Table 4 — Configuration and system design data

Name	Symbol	Unit	Range	Origin module	Varying
design over-temperature		K	5...60	M3-1	Yes

6.3.4   Operating or boundary conditions

Required operating conditions data for this calculation procedure are listed in Table 5.

Table 5 — Operating conditions data list

Name	Symbol	Unit	Range	Origin module	Varying
Operating conditions					
initial internal temperature	$\theta_{int,ini}$	°C	0...50	M3-2	Yes
calculation interval	t_{ci}	h	1...8 760	M1-9	Yes
total time of generator(s) operation	t_{gnr}	h	0...8 760	M1-6	Yes
external temperature of the calculation interval	$\theta_{e,avg}$	°C	−50...+50	M1-13	Yes
thermal output of the heating/cooling emission system	$Q_{em;out}$	kWh	0...	M3-3/M4-3	Yes

Name	Symbol	Unit	Range	Origin module	Varying
Operating conditions					
operation time of the fans in the calculation period	$t_{h,rl}$	h	0...8 760	M1-6	Yes
analytical running time (monthly or other period)	t_h	h	0...8 760	M1-6	Yes

6.4 Calculation procedure

### 6.4.1 Applicable calculation interval

This calculation procedure can be used with the following calculation interval: hourly, monthly or yearly.

6.4.2 Energy calculation (additional heating/cooling losses)

This subclause gives a detailed method for the calculation of losses in the heating/cooling emission systems or in the cooling system (for the cooling case the loss is a heat loss with a negative sign). The concept uses the equivalent internal temperature.

This document presents an overall method to calculate the additional heat/cooling losses and energy efficiency. In Annex A only the structure of the tables is included. Default values for the calculation are given in Annex B. The internal temperature is affected by the following (see Figure 1):

— the spatial temperature variation due to the stratification, depending on the emitter;

— the control variation depending on the capacity of the control device to assure a homogeneous and constant temperature;

— the temperature variation based on additional heating/cooling losses by emitters embedded in the envelope;

— the temperature variation based on radiation heat transfer of the emitter;

— the temperature variation based on intermittent operation of controls and emitters;

— the temperature variation based on imbalanced hydraulic systems;

— the temperature variation based on a space automation system;

— the temperature variation based on a controls system with standalone or networked operation of the system;

— the temperature variation based on type of emitter.
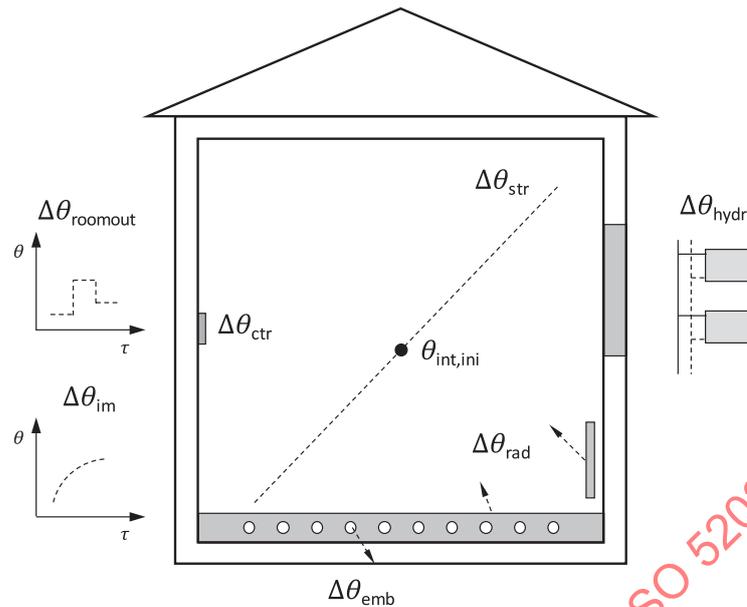
Key

$\Delta\theta_{im}$ temperature variation based on intermittent operation and based on the type of emission system (K),

$\Delta\theta_{roomaut}$ temperature variation based on standalone or networked operation/ space automation of the system (K)

$\Delta\theta_{ctr}$ control variation (K)

$\Delta\theta_{emb}$ temperature variation based on an additional heating/cooling losses of embedded emitters or by undirected (flat) radiant emitters like radiant panels installed in the upper area of the room (K)

$\theta_{int;inc}$ equivalent internal temperature (K)

$\Delta\theta_{rad}$ temperature variation based on radiation by the type of emission system (K)

$\Delta\theta_{str}$ spatial variation of temperature due to stratification (K)

$\Delta\theta_{hydr}$ temperature variation based on not balanced hydraulic systems (K)

The control variation $\Delta\theta_{ctr}$ is divided into $\Delta\theta_{ctr,1}$ and $\Delta\theta_{ctr,2}$. $\Delta\theta_{ctr,1}$ should be used for standard calculation if no information is available. $\Delta\theta_{ctr,2}$ should be used for calculation with certified products. Alternatively, product specific values can be used if proved by certification.

Figure 1 — Temperature differences in the room based on different sources

The temperature variation based on intermittent operation and based on the type of emission system shown in Figure 1 is calculated by Formula (1):

$$\Delta\theta_{im} = \Delta\theta_{im,emt} + \Delta\theta_{im,ctr} \tag{1}$$

where

$\Delta\theta_{im,emt}$ is the temperature variation based on intermittent operation on the type of the emission system (K);

$\Delta\theta_{im,ctr}$ is the temperature variation based on intermittent operation of control (K).

The equivalent internal temperature, $\theta_{int;inc}$ taking into account the emitter, is calculated by Formulae (2) and (3):

$$\theta_{H;int;inc} = \theta_{H;int;ini} + \Delta\theta_{int;inc} \tag{2}$$

$$\theta_{\text{C;int;inc}} = \theta_{\text{C;int;ini}} - \Delta\theta_{\text{int;inc}} \tag{3}$$

where

$\theta_{\text{H;int,ini}}$ is the initial internal heating temperature (°C);

$\theta_{\text{C;int,ini}}$ is the initial internal cooling temperature (°C);

$\Delta\theta$ is the temperature variation, e.g. $\Delta\theta = \Delta\theta_{\text{ctr}} + \Delta\theta_{\text{str}} + \Delta\theta_{\text{emb}}$ (K);

$\Delta\theta_{\text{int;inc}}$ is the temperature variation based on all losses (K) [see Formula (4)].

NOTE 1   Room/space automation system covers room wide temperature controls including an individual timer function, timer function with self-adoption of start/stop or timer function with self-adoption of start/stop and interaction with other controls or heating/cooling system devices.

$$\Delta\theta_{\text{int;inc}} = \Delta\theta_{\text{str}} + \Delta\theta_{\text{ctr}} + \Delta\theta_{\text{emb}} + \Delta\theta_{\text{rad}} + \Delta\theta_{\text{im}} + \Delta\theta_{\text{hydr}} + \Delta\theta_{\text{roomaut}} \tag{4}$$

In case of using product data for control systems, $\Delta\theta_{\text{ctr}}$ = CA-value.

Electronic controllers   CA is based on EN 15500-1 (see Table 6).

Thermostatic controllers (TRV)   is based on EN 215 (see Table 6).

Temperature variation based on emission system is shown in Formula (5):

$$\Delta\theta_{\text{emt,syst}} = \Delta\theta_{\text{str}} + \Delta\theta_{\text{emb}} + \Delta\theta_{\text{rad}} + \Delta\theta_{\text{im,emt}} \tag{5}$$

where

$\Delta\theta_{\text{rad}}$ is calculated for radiators in EN 442 (all parts) (see Table 6);

$\Delta\theta_{\text{im,emt}}$ is calculated for embedded systems in EN 1264-2 (see Table 6).

Temperature variation based on control system is shown in Formula (6):

$$\Delta\theta_{\text{ctr,syst}} = \Delta\theta_{\text{ctr}} + \Delta\theta_{\text{im,ctr}} + \Delta\theta_{\text{roomaut}} \tag{6}$$

The equivalent internal temperature difference, $\Delta\theta_{\text{int;inc}}$ taking into account the emitter, is calculated using Formula (7):

$$\Delta\theta_{\text{int,inc}} = \Delta\theta_{\text{hydr}} + \Delta\theta_{\text{emt,syst}} + \Delta\theta_{\text{ctr,syst}} \tag{7}$$

In case of rooms with ceiling heights ≥4 m, the temperature variation $\Delta\theta_{\text{str}}$ is calculated as a specific value for different emitter systems using Formula (8):

$$\Delta\theta_{\text{str}} = 10 \cdot \frac{\theta'_{\text{str}}}{a} \cdot \left(0{,}5 \cdot h_{\text{R}} - b\right) \tag{8}$$

where

$a = 16\,\text{K}$;

$b = 1{,}1\,\text{m}$;

h_{R} is the room height (m);

θ'_{str} is the air temperature gradient (K/m) taken from Table A.8/B.8.

In case of rooms with ceiling heights ≥4 m, the temperature variation $\Delta\theta_{\text{rad}}$ is calculated as a specific value for different ceiling heights and emitter systems of radiant luminous and tube heaters using Formula (9):

$$\Delta\theta_{\text{rad}} = 10 \cdot \left[\frac{0,36}{\text{RF}+0,2} + 0,354 \cdot \left(\frac{70}{p_h}\right)^{0,12} \cdot \left(\frac{10}{h_R}\right)^{0,15} - 0,9 \right] \tag{9}$$

where

    RF   is the radiant factor of radiant heaters according to EN 416 with respect to EN 419 (product value);

    p_h is the specific heat power in W/m² based on product values.

NOTE 2   Formulae for $\Delta\theta_{\text{rad}}$ for radiant panels can be contained in national annexes. The accordant values are determined on the basis of radiant heat transfer according to EN 14037-3 (see Table 6). Values for radiant heat transfer of radiant panels according to EN 14037-2 cannot be compared directly with values of radiant factors of radiant heaters according to EN 416 with respect to EN 419 (see Table 6).

In case of using standard designs of radiant luminous or radiant tube heaters for ceiling heights ≥4 m, standard product values of RF are taken from Table A.9/B.9.

Table 6 — Interaction between product values and terms in EN 15316-2

Product	Relevant standard	Term
free heating surface (radiators)	EN 442 (all parts)	θ_{rad}
embedded heating and cooling systems	ISO 11855-7	$\theta_{\text{im,emt}}$
not embedded radiant heating and cooling systems (open air gap)	ISO 18566-6	$\theta_{\text{im,emt}}$
thermostatic controllers (TRV)	EN 215	θ_{ctr} = CA
electronic controllers	EN 15500-1	θ_{ctr} = CA
radiant luminous and tube heaters	EN 416 with respect to EN 419	RF
fan assisted radiators	EN 16430-2	θ_{rad}
electrical radiators	EN 14337	θ_{rad}
electric infra-red emitters for industrial heating	EN 60240-1	RF

The additional heat/cooling losses of emission in kWh are calculated using Formula (10):

$$Q_{\text{em,ls}} = Q_{\text{em,out}} \cdot \left(\frac{\Delta\theta_{\text{int,inc}}}{\theta_{\text{int,inc}} - \theta_{\text{e,comb}}} \right) \tag{10}$$

Where for heating emission [see Formula (11)]:

$$\theta_{\text{e,comb}} = \theta_{\text{e,avg}} \tag{11}$$

and for cooling emission [see Formula (12)]:

$$\theta_{\text{e,comb}} = \theta_{\text{e,avg}} + \Delta\theta_{\text{e,sol}} \tag{12}$$

NOTE 3   The values $\theta_{\text{e,avg}}$ is an input value from EN 15316-1. Default values for $\Delta\theta_{\text{e,sol}}$ are given in B.9.

In individual application cases this breakdown is not required. The annual losses for the heating and cooling emission in the room space is calculated using Formula (13):

$$Q_{em,ls,an} = \sum Q_{em,ls} \tag{13}$$

where

$Q_{em,ls,an}$ is the annual loss of the heating/cooling emission, in kWh;

$Q_{em,ls}$ is the loss of the heating/cooling emission (in the time period), in kWh.

The annual thermal output of the heating/cooling emission in the room space is calculated using Formula (14):

$$Q_{em,out,an} = \sum Q_{em,out} \tag{14}$$

A heating/cooling system may, as required, be split up in zones with different heating/cooling emission systems, and the heating/cooling loss calculations can be applied individually for each zone. The considerations given in ISO 52000-1 regarding splitting up or branching of the heating/cooling system shall be followed. If the principle of adding up the heating/cooling losses is respected, it is always possible to combine zones with different heating/cooling emission systems.

Based on the result of the calculation a characteristic value (annual expenditure factor) for heat and cooling emission can be calculated using Formula (15).

$$\varepsilon_{em,ls,an} = \frac{Q_{em,out,an} + Q_{em,ls,an}}{Q_{em,out,an}} \tag{15}$$

6.4.3 Auxiliary energy calculation

Using Formula (16), the auxiliary energy is balanced so that it serves to improve the heating/cooling emission processes in the room space and is not recorded in the above calculations.

$$W_{em,ls,aux} = W_{fan} \tag{16}$$

where

$W_{em,ls,aux}$ is the auxiliary energy (in the period), in kWh;

W_{fan} is the auxiliary energy of fans in the calculation period, in kWh;

The individual component W_{fan} is determined using Formula (17).

$$W_{fan} = \sum \frac{P_{fan} \cdot n_{fan} \cdot t_{h,rL}}{1\,000} \tag{17}$$

where

n_{fan} is the number of ventilator/fan units;

$t_{h,rL}$ is the operation time of the system in the calculation period, in hours

P_{fan} is the electrical rated power consumption of the ventilators/fans (from Table A.13/B.13 or product data), in W.

Auxiliary energy calculation in large indoor space buildings (h > 4 m) – systems with direct heating

Especially in large buildings, decentralized heating systems are sometimes used, which combine the subsystems of heat generation and heat transfer in a single unit and which are installed in the room to be heated (e.g. gas infrared radiators).

The total auxiliary energy of these systems is credited to the heat and cooling demand of the installation room space using Formula (18) (see Table A.13/B.13, upper section):

$$W_{\text{em,ls,aux}} = \sum \frac{P_{\text{H,aux}} \cdot n_{\text{H,aux}} \cdot t_{\text{h}}}{1\,000} \tag{18}$$

where

$W_{\text{em,ls,aux}}$ is the monthly or other period auxiliary energy (heat emission and, if necessary, heat generation), in kWh;

$P_{\text{H,aux}}$ is the rated power consumption of the equipment from Table A.12/B.12 or manufacturer data (heat generation and heat emission), in W;

$n_{\text{H,aux}}$ is the number of equipment;

t_{h} is the monthly or other period analytical running time, in hours.

The operating duration of the ventilator/fan including control system is set equal to the operating time of the heating system. Table A.13/B.13 prescribe the standard values for the auxiliary energy of fans and for the control system in room spaces h > 4 m in height (large indoor space buildings).

Annex A
(normative)

Template for choices, input data and references (additional heating and cooling losses/auxiliary energy)

A.1 General

The template in Annex A of this document shall be used to specify the choices between methods, the required input data and references to other documents.

NOTE 1   Following this template is necessary, but not enough to guarantee consistency of data.

NOTE 2   Informative default choices are provided in Annex B. Alternative values and choices can be imposed by national/regional regulations. If the default values and choices of Annex B are not adopted because of the national/regional regulations, policies or national traditions, it is expected that:

— national or regional authorities prepare data sheets containing the national or regional values and choices, in line with the template in Annex A; or

— by default, the national standards body will add or include a national annex (Annex NA) to this document, in line with the template in Annex A, giving national or regional values and choices in accordance with their legal documents.

NOTE 3   The template in Annex A is applicable to different applications (e.g. the design of new building, certification of new building, renovation of an existing building and certification of existing building) and for different types of buildings (e.g. small or simple buildings and large or complex buildings). A distinction in values and choices for different applications or building types could be made:

— by adding columns or rows (one for each application), if the template allows;

— by including more than one version of a table (one for each application), numbered consecutively as a, b, c, … For example: Table NA.3a, Table NA.3b;

— by developing different national/regional data sheets for the same standard. In case of a national annex to the standard these will be consecutively numbered (Annex NA, Annex NB, Annex NC, …).

NOTE 4   In the section "Introduction" of a national/regional data sheet information can be added, for example about the applicable national/regional regulations.

NOTE 5   For certain input values to be acquired by the user, a data sheet following the template of Annex A could contain a reference to national procedures for assessing the needed input data. For instance, reference to a national assessment protocol comprising decision trees, tables and pre-calculations.

If product specific values are available these may be used instead of the values in Tables A.1 to A.13 (compare to Annex C).

The temperature variation for hydraulic balancing is described in Table A.1.

Table A.1 — Default values for temperature variation for hydronic balancing in K

Influence parameters				
(Performed hydronic balancing with manufacturer's declaration in coordination with EN 14336)				
One pipe heating	$\Delta\theta_{hydr}$	**Two pipe heating**	n ≤ 10[a] $\Delta\theta_{hydr}$	n > 10[a] $\Delta\theta_{hydr}$
No hydronic balancing		No hydraulic balancing		
Balanced statically per circuit		Balanced statically per free heating surface (radiator) or embedded heating surface, without group balance		
Balanced dynamically per circuit (e.g. with automatic flow limiters)		Balanced statically per free heating surface (radiator) or embedded heating surface, with group balance (e.g. with balancing valve)		
Balanced dynamically per circuit (e.g. with automatic flow limiters) and dynamically controlled depending on its load (e.g. return temperature limitation)		Balanced statically per free heating surface (radiator) or embedded heating surface (radiator) and dynamic group balance (e.g. with differential pressure controller)		
Balanced dynamically per circuit (e.g. with automatic flow limiters) and dynamically controlled depending on its load (supply-return temperature difference)		Balanced dynamically per free heating surface (radiator) or embedded heating surface (e.g. with automatic flow limiters/differential pressure controllers)		
[a] n = number of heat and cooling emission systems (e.g. number of radiators).				

A.2   Temperature variation for free heating surfaces (radiators), room heights ≤4 m (heating case)

In Table A.2 the temperature variation for free heating surfaces are described.

Table A.2 — Temperature variation free heating surfaces (radiators), room heights ≤ 4 m (heating case)

Influence parameters		Variation			
		$\Delta\theta_{str}$	$\Delta\theta_{ctr,1}$ [b]	$\Delta\theta_{ctr,2}$ [c]	$\Delta\theta_{emb}$
Room space temperature regulation	Unregulated, with central supply temperature regulation				
	Master room space or one-pipe heating				
	Room temperature control (electromechanical/electronic)				
	P-controller (before 1988)				
	P-controller				
	PI-controller				
	PI-controller (with optimisation function, e.g. presence management, adaptive controller)				
Over-temperature (reference θ_i = 20 °C)[f]		$\Delta\theta_{str,1}$	$\Delta\theta_{str,2}$		
	Two-pipe heating and one-pipe heating renovated[d]				
	60 K (e.g. 90/70)				
	42,5 K (e.g. 70/55)				
	30 K (e.g. 55/45)				
	20 K (e.g. 45/35)				
	One-pipe heating (not renovated)				
	60 K (e.g. 90/70)				
	42,5 K (e.g. 70/55)				
	Heating systems combined with mechanical ventilation[e]				
	Fan assisted radiators/fan coil units[e]				
Specific heat losses via external components (GF = glass surface area)	Radiator location internal wall				
	Radiator location external wall				
	— GF without radiation protection				
	— GF with radiation protection[a]				
	— external wall				

[a] The radiation protection shall prevent 80% of the radiation losses from the heating body to the glass surface area by means of insulation and/or reflection.

[b] Use $\Delta\theta_{ctr,1}$ for uncertified products.

[c] Use $\Delta\theta_{ctr,2}$ for certified products.

[d] One-pipe heating is assumed as renovated if the flow rate is dynamically controlled depending on the load and the distribution pipes are insulated.

[e] When heating systems are installed in rooms equipped with mechanical ventilation systems the temperature stratification is influenced.

[f] See Table 4.

For $\Delta\theta_{str}$ an average value is to be formed from the data for the main influence parameters "over-temperature" and "specific heat losses via external components" using Formula (A.1):

$$\Delta\theta_{str} = (\Delta\theta_{str,1} + \Delta\theta_{str,2})/2 \qquad (A.1)$$

Temperature variation for intermittent operation:

  controls $\Delta\theta_{im,ctr}$ = …

  emitters $\Delta\theta_{im,emt}$ = …

Temperature variation for radiation effect: $\Delta\theta_{rad}$ = …

Alternatively, product specific values for $\Delta\theta_{rad}$ in accordance to product standards can be used.

Temperature variation for room automation: $\Delta\theta_{roomaut}$ = …

  stand alone[1]

  stand alone with self-adoption start/stop[2]

  networked with self-adoption and interaction[3]

  (Interaction in the form of individual room control system includes the connection of the individual room control system with additional controls and/or the heat source, for example, supply temperature adaptation.)

A.3   Temperature variation for component-integrated heating surfaces (panel heaters) (room heights ≤4 m, heating case)

In Table A.3 the temperature variation for component-integrated heating surfaces (panel heaters) (room heights ≤4 m) are prescribed.

---

1)   Stand alone: app user interface to set weekly temperature schedules.

2)   Stand alone with self-adaption start/stop:
  —   Individual adaptive start heating function during energy saving periods to ensure the comfort temperature is not reached before needed and programmed by the user.
  —   Central away/home function common for all rooms.
  —   Window open detection on one unit operates all actuator/controllers in the same room.

3)   Networked with self-adaption and interaction:
  —   System supply temperature adaption to lower (higher: cooling) levels depending on demand detected by room units.
  —   System fault detection alarms on power loss (battery) and frost risk (room temperatures less than, e.g. 5 °C).

                         15

Table A.3 — Temperature variation for component-integrated heating surfaces (panel heaters); room heights ≤4 m (heating case)

Influence parameters		$\Delta\theta_{str}$	$\Delta\theta_{ctr,1}$ [a]	$\Delta\theta_{ctr,2}$ [b]	$\Delta\theta_{emb}$	
					Variation	
					$\Delta\theta_{emb,1}$	$\Delta\theta_{emb,2}$
Room space temperature regulation	Unregulated, with central supply temperature regulation					
	Master room space					
	Room temperature control (e.g. 2-step controller)					
	P-controller (before 1988)					
	P-controller/2-step controller (hysteresis ≤ ±0,5 K)					
	PI-controller					
	PI-controller (with optimisation function, e.g. presence management, adaptive controller)					
System	Floor heating — screed system — dry system — system with low cover					
	Wall heating					
	Ceiling heating					
	Heating systems combined with mechanical ventilation[c]					
Specific heat losses via laying surfaces	Integrated heating surface without minimum insulation in accordance with EN 1264-2					
	Integrated heating surface with minimum insulation in accordance with EN 1264-2					
	Integrated heating surface with 100 % better insulation than required by EN 1264-2					

[a] Use $\Delta\theta_{ctr,1}$ for not certified products.

[b] Use $\Delta\theta_{ctr,2}$ for certified products.

[c] When heating systems are installed in room equipped with mechanical ventilation systems the temperature stratification is influenced.

For $\Delta\theta_{emb}$ an average value is to be formed from the data for the main influence parameters "system" and "specific heat losses via laying surfaces" using Formula (A.2).

$$\Delta\theta_{emb} = (\Delta\theta_{emb,1} + \Delta\theta_{emb,2})/2 \tag{A.2}$$

In Table A.4 the overall temperature variation ($\Delta\theta = \Delta\theta_{ctr} + \Delta\theta_{str} + \Delta\theta_{emb}$) for thermally-activated building systems (room heights ≤ 4 m) are prescribed.

Table A.4 — Default values for temperature variation for component-integrated heating surfaces (thermally activated building systems); room heights ≤4 m; heating case

Influence parameters		Variation $\Delta\theta$
Control	Constant supply temperature	
	Central supply temperature regulation	

Temperature variation for radiation effect: $\Delta\theta_{rad}$ =

Alternatively, product specific values for $\Delta\theta_{rad}$ in accordance to product standards can be used.

Temperature variation for intermittent operation:

controls $\Delta\theta_{im,ctr}$ = ...

emitters $\Delta\theta_{im,emt}$ = ...

Temperature variation for room/space automation: $\Delta\theta_{roomaut}$ = ...

stand alone[4]

stand alone with self-adoption start/stop[5]

networked with self-adoption and interaction[6]

(Interaction in the form of individual room control system includes the connection of the individual room control system with additional controls and/or the heat source, for example, supply temperature adaptation.)

A.4 Temperature variation for air heating systems; room heights ≤4 m (heating case)

For air heating systems the calculation has to be done with the following values:

Air heating system (mixing case) $\Delta\theta_{str}$ =

$\Delta\theta_{ctr;1}$ =

$\Delta\theta_{ctr;2}$ =

$\Delta\theta_{emb}$ =

Temperature variation for intermittent operation:

controls $\Delta\theta_{im,ctr}$ =

emitters $\Delta\theta_{im,emt}$ =

Temperature variation for radiation effect: $\Delta\theta_{rad}$ =

Temperature variation for room automation:

stand alone[7] $\Delta\theta_{roomaut}$ =

---

4) Stand alone: app user interface to set weekly temperature schedules.

5) Stand alone with self-adaption start/stop:
   — Individual adaptive start heating function during energy saving periods to ensure the comfort temperature is not reached before needed and programmed by the user.
   — Central away/home function common for all rooms.
   — Window open detection on one unit operates all actuator/controllers in the same room.

6) Networked with self-adaption and interaction:
   — System supply temperature adaption to lower (higher: cooling) levels depending on demand detected by room units.
   — System fault detection alarms on power loss (battery) and frost risk (room temperatures less than e.g. 5 °C).

7) Stand alone: app user interface to set weekly temperature schedules.

stand alone with self-adoption start/stop[8] $\Delta\theta_{\text{roomaut}}$ =

networked with self-adoption and interaction[9] $\Delta\theta_{\text{roomaut}}$ =

(Interaction in the form of individual room control system includes the connection of the individual room control system with additional controls and/or the heat source — for example, supply temperature adaptation.)

A.5 Temperature variation for electrical heating (room heights ≤4 m, heating case)

In Table A.5 the temperature variation for electrical heating (room heights ≤4 m) are prescribed.

Table A.5 — Temperature variation for electrical heating and air heating systems in K (room heights ≤4 m, heating case)

Influence parameters		Variation $\Delta\theta$
External wall region	Air heating with zone control P-controller (1 K)	
	Air heating with central master control and pilot room control including supplementary heating with single-room control P-controller (1K)	
	E-direct heating P-controller (1 K) or air heating with single-room control P-controller (1 K)	
	E-direct heating PI-controller (with optimization) or air heating with single-room control PI-controller (with optimization)	
	Storage heating unregulated without external temperature dependent charging	
	Storage heating P-controller (1 K) with external temperature dependent charging	
	Storage heating PID-controller with optimization with external temperature dependent charging	
Internal wall region	Air heating with zone control P-controller (1 K)	
	Air heating with central master control and pilot room control including supplementary heating with single-room control P-controller (1K)	
	E-direct heating P-controller (1 K) or air heating with single-room control P-controller (1 K)	
	E-direct heating PI-controller (with optimization) or air heating with single-room control PI-controller (with optimization)	
	Storage heating unregulated without external temperature dependent charging	
	Storage heating P-controller (1 K) with external temperature dependent charging	
	Storage heating PID-controller with optimization with external temperature dependent charging	
Ventilation systems with supply air temperature below the room temperature		

---

8)   Stand alone with self-adaption start/stop:
   — Individual adaptive start heating function during energy saving periods to ensure the comfort temperature is not reached before needed and programmed by the user.
   — Central away/home function common for all rooms.
   — Window open detection on one unit operates all actuator/controllers in the same room.

9)   Networked with self-adaption and interaction:
   — System supply temperature adaption to lower (higher: cooling) levels depending on demand detected by room units.
   — System fault detection alarms on power loss (battery) and frost risk (room temperatures less than e.g. 5 °C).

Temperature variation for intermittent operation: $\Delta\theta_{\mathrm{im}}$ = … (to be used for electrical heating systems with an integrated feedback control system)

Temperature variation for radiation effect: $\Delta\theta_{\mathrm{rad}}$ =

Alternatively, product specific values for $\Delta\theta_{\mathrm{rad}}$ in accordance to product standards can be used.

A.6   Temperature variation air heating (ventilation systems, room heights ≤4 m, heating case)

In Table A.6 the temperature variation $\Delta\theta_{\mathrm{em,ls}}$ for air heating (non-domestic ventilation systems, room heights ≤4 m) are prescribed.

Table A.6 — Temperature variation for air heating (non-domestic ventilation systems, room heights ≤4 m, heating case)

System configuration	Control parameter	$\Delta\theta$	
		Low quality of control	High quality of control
Additional heating in the incoming air (additional heater)	Room space temperature		
	Room space temperature (cascade control of incoming air temperature)		
	Exhaust air temperature		
Recirculation air heating (induction equipment, ventilator convectors, fan coil units)	Room space temperature		

NOTE   The auxiliary energy for the recirculation air heating is given in Table B.2.

A.7   Temperature variation for room spaces with heights >4 m (large indoor space buildings, heating case)

In Table A.7 the temperature variation for room spaces with heights ≥4 m is prescribed.

**Table A.7 — Temperature variation for room spaces with heights >4 m
(heating case) reference case: Ceiling height 10 m, standard product values radiant factors
of luminous and tube heaters and tube heaters)**

Influence parameters			Variation		
			$\Delta\theta_{ctr,1}$[a]	$\Delta\theta_{ctr,2}$[b]	$\Delta\theta_{emb}$
Room space temp. regulation	Unregulated				
	Two-step controller				
	P-controller				
	PI-controller				
	PI-controller with optimisation				
	Warm air without additional vertical recirculation	Outlet horizontal (wall unit)			
		Outlet horizontal (wall unit) low temperature system[c] (valid only up to ceiling heights of 6 m)			
		Outlet from above (ceiling unit)			
		Outlet from vertical (ceiling unit) low temperature system[d] (valid only up to ceiling heights of 6 m)			
	Warm air with additional vertical recirculation or adjustable induction outlet	Recirculation controlled by two-step controller			
		Recirculation controlled by PI-controller			
	Radiant tube heaters	Standard design			
		Improved design			
	Luminous heaters	Standard design			
		Improved design			
	Radiant ceiling panels	Standard design			
		Improved design			
		Improved design and keeping distances to the wall			
	Floor heating	Without isolation (coverage ≤10 cm)			
		Without isolation (coverage >10 cm)			
		Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage ≤10 cm)]			
		Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage >10 cm)]			
		Thermally decoupled [$U_{bottom\ plate}$ ≤ 0,35 W/(m²K)] and coverage ≤10 cm			

[a] Use $\Delta\theta_{ctr,1}$ for not certified products.

[b] Use $\Delta\theta_{ctr,2}$ for certified products.

[c] The outcoming temperature shall be maximum 15 K higher than the required internal temperature; the value $\Delta\theta_{str}$ = 1,03 may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str}$ = 2,93 shall be used.

[d] The outcoming temperature shall be maximum 15 K higher than the required internal temperature; the value $\Delta\theta_{str}$ = 1,03 may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str}$ = 1,76 shall be used.

Table A.8 — Air temperature gradient for rooms with ceilings heights >4 m

Emitter system		Air temperature gradient θ'_{str} [K/m]
Warm air heaters <u>without</u> additional vertical recirculation	Outlet horizontal (wall unit)	
	Outlet horizontal (wall unit) low temperature system (valid only up to ceiling heights of 6 m)	
	Outlet from above (ceiling unit)	
	Outlet from above (ceiling unit) low temperature system (valid only up to ceiling heights of 6 m)	
Warm air heaters <u>with</u> additional vertical recirculation	Recirculation controlled by two-step controller	
	Recirculation controlled by PI-controller	
Radiant tube heaters	Standard design	
	Improved design[a]	
Luminous heaters	Standard design	
	Improved design[b]	
Radiant ceiling panels	Standard design	
	Improved design	
	Improved design and keeping distances to the wall	
Floor heating	Without isolation (coverage ≤10 cm)	
	Without isolation (coverage >10 cm)	
	Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage ≤10 cm)]	
	Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage >10 cm)]	
	Thermally decoupled [($U_{bottom\ plate}$ ≤ 0,35 W/(m²K)] and coverage ≤10 cm	

[a] Improved design radiant tube heaters: feature construction with completely insulated reflector; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according to EN 416 shall be minimum 0,69.

[b] Improved design radiant luminous heaters: feature construction with reflector overstreamed by flue gases; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according to EN 419 shall be minimum 0,69.

Table A.9 — Standard product values of radiant factors for radiant luminous and radiant tube heaters in rooms with ceiling heights >4 m

Heater	Classification	RF
Radiant tube heater	Standard	
	Improved design[a]	
Radiant luminous heaters	Standard	
	Improved design[b]	

[a] Improved design radiant tube heaters: feature construction with completely insulated reflector; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according to EN 416 shall be minimum 0,69.

[b] Improved design radiant luminous heaters: feature construction with reflector overstreamed by flue gases; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according to EN 419 shall be minimum 0,69.

A.8   Temperature variation for room heaters fired by solid fuel

In Table A.10 the temperature variation for room heaters fired by solid fuel are prescribed.

Table A.10 — Temperature variation for room heaters fired by solid fuel

Influence parameters		Variation		
		$\Delta\theta_{str}$	$\Delta\theta_{ctrl,1}$	$\Delta\theta_{ctrl,2}$
System	Used on one single floor			
	Used for 2 floors			
Control	Manual thermostat			
	Room thermostat			

A.9   Temperature variation for water-based cooling systems; room heights ≤4 m (cooling case)

Table A.11 — Temperature variation for cooling systems; room heights ≤4 m (cooling case)

Influence parameters		Variation			
		$\Delta\theta_{str}$	$\Delta\theta_{ctr,1}$[a]	$\Delta\theta_{ctr,2}$[b]	$\Delta\theta_{emb}$
Room space temperature regulation	Unregulated, with central supply temperature regulation				
	Master room space or one-pipe heating				
	Room temperature control (electromechanical/electronic)				
	P-controller (before 1988)				
	P-controller				
	PI-controller				
	PI-controller (with optimisation function, e.g. presence management, adaptive controller)				
System	Floor cooling system				
	Wall cooling				
	Ceiling cooling				
	Radiators assisted with fan/fan coil unit				
	— located on the ceiling				
	— located on external wall				
[a] Use $\Delta\theta_{ctr,1}$ for not certified products.					
[b] Use $\Delta\theta_{ctr,2}$ for certified products.					

For $\Delta\theta_{emb}$ an average value is to be formed from the data for the main influence parameters "system" and "specific heat losses via laying surfaces".

Temperature variation for consideration of solar and internal gains:

average proportion of window area or internal loads (e.g. residential buildings)

$$\Delta\theta_{e,sol}\quad=$$

high proportion of window area or internal loads (e.g. office buildings)

$$\Delta\theta_{\mathrm{e,sol}} \quad =$$

Temperature variation for intermittent operation:

controls $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \Delta\theta_{\mathrm{im,ctr}} =$

emitters $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \Delta\theta_{\mathrm{im,emt}} \quad =$

Temperature variation for radiation effect: $\quad \Delta\theta_{\mathrm{rad}} \quad\quad =$

Alternatively, product specific values for $\Delta\theta_{\mathrm{rad}}$ in accordance to product standards can be used.

Temperature variation for room automation:

stand alone[10] $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \Delta\theta_{\mathrm{roomaut}} =$

stand alone with self-adoption start/stop[11] $\quad \Delta\theta_{\mathrm{roomaut}} =$

networked with self-adoption and interaction[12] $\Delta\theta_{\mathrm{roomaut}} =$

(Interaction in the form of individual room control system includes the connection of the individual room control system with additional controls and/or the heat source — for example, supply temperature adaptation.)

A.10 Auxiliary energy

In Tables A.12–A.15 the default values for auxiliary energy components are prescribed.

Table A.12 — Default values for electrical power for the control system

Influence parameters		Power (W)
Control system with auxiliary energy P_{ctr}	Electrical control system with electrical motor actuation	
	Electrical control system with electro thermal actuation	
	Electrical control system with electromagnetic actuation	

Table A.13 — Default values for electrical power of fans for air supply in room spaces h ≤ 4 m

Influence parameters		Power (W)
Ventilator/ fan P_{fan}	Fan coils unit	
	E-direct heating fan coils unit	
	Storage heating with dynamic discharge	
	Storage heating with continuous dynamic discharge	

---

10) Standalone: app user interface to set weekly temperature schedules.

11) Standalone with self-adaption start/stop:
— Individual adaptive start heating function during energy saving periods to ensure the comfort temperature is not reached before needed and programmed by the user.
— Central away/home function common for all rooms.
— Window open detection on one unit operates all actuator/controllers in the same room.

12) Networked with self-adaption and interaction:
— System supply temperature adaption to lower (higher: cooling) levels depending on demand detected by room units.
— System fault detection alarms on power loss (battery) and frost risk (room temperatures less than e.g. 5 °C).

For heating systems in room spaces with a height $h > 4$ m and decentralized heat generator the system is a part of heat generation and heat emission (luminous heaters). The complete auxiliary energy is for such a system a part of heat emission. Default values are given in Table A.14.

Table A.14 — Standard values for electrical power of fans and for the control system in room spaces h > 4 m in height (large indoor space buildings) — Decentralized system

Influence parameters		Power (W)
$P_{H,aux}$ Directly heated heat generator (installed in the working space)	Luminous heaters (control and regulation)	
	Radiant tube heaters up to 50 kW (control, regulation and fan for combustion air supply)	
	Radiant tube heaters above 50 kW (control, regulation and fan for combustion air supply)	
	Warm air generator with atmospheric burner and recirculation air axial fan (control, regulation and fan for combustion air supply)	
	Warm air generator with fan-assisted burner and recirculation air radial ventilator (control, regulation and fan for combustion air supply, fan for warm air supply)	
Φ_{HL} is determined from EN 12831-2.		

For heating systems in room spaces with a height $h > 4$ m and central heat generator and a separate unit for heat emission in the rooms auxiliary energy is needed (indirect air heater). This additional energy is a part of the heat emission in the room. For such systems Table A.15 gives some default values.

Table A.15 — Default values for electrical power of fans and for the control system in room spaces with central heat generator — Air heating systems

Influence parameters			Power (W)
Indirect space heating with a room height ≤8 m	with warm-air return	with asynchronous motor	
		with a regulated EC motor	
	without warm-air return	with asynchronous motor	
		with a regulated EC motor	
Indirect space heating with a room height >8 m	without warm-air return	with asynchronous motor	
		with a regulated EC motor	
	with warm-air return	with asynchronous motor	
		with a regulated EC motor	

A.11 Additional information

Table A.16 shows a classification of the controllers in relation to EN 15232-1.

Table A.16 — Classification of the controllers in relation to EN 15232-1

This document (ISO 52031)	EN 15232-1 – BACS function	Identifier
Unregulated, with central supply temperature regulation		
Master room space or one-pipe heating		
Room temperature control (electromechanical/electronic)		
P-controller (before 1988)		
P-controller		
PI-controller		
PI-controller (with optimisation function, e.g. presence management, adaptive controller)		

In Table A.17 the default values for convective fraction $f_{em,conv}$ of the heating/cooling emitter are prescribed.

Table A.17 — default values for convective fraction of heating/cooling emitters

System		$f_{em,conv}$
Heating	Air heating (convectors, fan coils…)	
	Free heating surface (radiators, radiant panels…)	
	Floor heating, low temperature radiant tube heaters, luminous heaters, wood stoves	
	Wall heating, radiant ceiling panels, accumulation stoves	
	Ceiling heating, radiant ceiling electric heating	
Cooling	Cold air blowing systems (fan coils…)	
	Chilled beams	
	Ceiling cooling	
	Wall cooling	
	Floor cooling	

Annex B
(informative)

Default choices, input data and references (additional heating and cooling losses/auxiliary energy)

B.1 General

The template in Annex A of this document shall be used to specify the choices between methods, the required input data and references to other documents.

NOTE 1   Following this template is not enough to guarantee consistency of data.

NOTE 2   Informative default choices are provided in Annex B. Alternative values and choices can be imposed by national/regional regulations. If the default values and choices of Annex B are not adopted because of the national/regional regulations, policies or national traditions, it is expected that:

— national or regional authorities prepare data sheets containing the national or regional values and choices, in line with the template in Annex A; or

— by default, the national standards body will add or include a National Annex (Annex NA) to this document, in line with the template in Annex A, giving national or regional values and choices in accordance with their legal documents.

NOTE 3   The template in Annex A is applicable to different applications (e.g. the design of a new building, certification of a new building, renovation of an existing building and certification of an existing building) and for different types of buildings (e.g. small or simple buildings and large or complex buildings). A distinction in values and choices for different applications or building types could be made:

— by adding columns or rows (one for each application), if the template allows;

— by including more than one version of a Table (one for each application), numbered consecutively as a, b, c, … For example: Table NA.3a, Table NA.3b;

— by developing different national/regional data sheets for the same standard. In case of a national annex to the standard these will be consecutively numbered (Annex NA, Annex NB, Annex NC, …).

NOTE 4   In the section "Introduction" of a national/regional data sheet information can be added, for example about the applicable national/regional regulations.

NOTE 5   For certain input values to be acquired by the user, a data sheet following the template of Annex A could contain a reference to national procedures for assessing the needed input data. For instance, reference to a national assessment protocol comprising decision trees, tables and pre-calculations.

If product specific values are available, these may be used instead of the values in Tables B.1–B.13 (compare to Annex C).

The default values for temperature variation for hydronic balancing are prescribed in Table B.1.

Table B.1 — Default values for temperature variation for hydronic balancing in K

Influence parameters				
(Performed hydronic balancing with manufacturer's declaration on the balance and in coordination with EN 14336)				
One pipe heating	$\Delta\theta_{hydr}$	Two pipe heating	n ≤ 10[a] $\Delta\theta_{hydr}$	n > 10[a] $\Delta\theta_{hydr}$
No hydronic balancing	0,7	No hydraulic balancing	0,6	
Balanced statically per circuit	0,4	Balanced statically per free heating surface (radiator) or embedded heating surface, without group balance	0,3	0,4
Balanced dynamically per circuit (e.g. with automatic flow limiters)	0,3	Balanced statically per free heating surface (radiator) or embedded heating surface, with group balance (e.g. with balancing valve)	0,2	0,3
Balanced dynamically per circuit (e.g. with automatic flow limiters) and dynamically controlled depending on its load (e.g. return temperature limitation)	0,2	Balanced statically per free heating surface (radiator) or embedded heating surface (radiator) and dynamic group balance (e.g. with differential pressure controller)	0,1	0,2
Balanced dynamically per circuit (e.g. with automatic flow limiters) and dynamically controlled depending on its load (supply-return temperature difference)	0,1	Balanced dynamically per free heating surface (radiator) or embedded heating surface (e.g. with automatic flow limiters/differential pressure controllers)	0,0	
[a] n = number of heat and cooling emission systems (e.g. number of radiators...).				

B.2   Temperature variation for free heating surfaces (radiators); room heights ≤4 m (heating case)

In Table B.2 the temperature variation for free heating surfaces are described.

Table B.2 — Default values for temperature variation for free heating surfaces (radiators) in K; room heights ≤4 m, heating case

Influence parameters		Variation			
		$\Delta\theta_{str}$	$\Delta\theta_{ctr,1}$ [b]	$\Delta\theta_{ctr,2}$ [c]	$\Delta\theta_{emb}$
Room space temperature regulation	Unregulated, with central supply temperature regulation		2,5	2,5	
	Master room space or one-pipe heating		2	1,8	
	Room temperature control (electromechanical/electronic)		1,8	1,6	
	P-controller (before 1988)		1,4	1,4	
	P-controller		1,2	0,7	
	PI-controller		1,2	0,7	
	PI-controller (with optimisation function, e.g. presence management, adaptive controller)		0,9	0,5	
		$\Delta\theta_{str;1}$	$\Delta\theta_{str;2}$		
Over-temperature (reference θ_i = 20 °C)[f]	Two-pipe heating and one-pipe heating renovated[d]				
	60 K (e.g. 90/70)	1,2			
	42,5 K (e.g. 70/55)	0,7			
	30 K (e.g. 55/45)	0,5			
	20 K (e.g. 45/35)	0,4			
	One-pipe heating (not renoveted)				
	60 K (e.g. 90/70)	1,6			
	42,5 K (e.g. 70/55)	1,2			
	Heating systems combined with mechanical ventilation	0,2			
	Fan assisted radiators/fan coil units[e]	0			
Specific heat losses via external components (GF = glass surface area)	Radiator location internal wall		1,3		0
	Radiator location external wall				
	— GF without radiation protection		1,7		0
	— GF with radiation protection[a]		1,2		0
	— external wall		0,3		0
[a] The radiation protection shall prevent 80 % of the radiation losses from the heating body to the glass surface area by means of insulation and/or reflection.					
[b] Use $\Delta\theta_{ctr,1}$ for not certified products.					
[c] Use $\Delta\theta_{ctr,2}$ for certified products.					
[d] One-pipe heating is assumed as renovated, if the flow rate is dynamically controlled depending on the load and the distribution pipes are insulated.					
[e] When heating systems are installed in rooms equipped with mechanical ventilation systems the temperature stratification is influenced.					
[f] See Table 4.					

For $\Delta\theta_{str}$ an average value is to be formed from the data for the main influence parameters "over-temperature" and "specific heat losses via external components".

$$\Delta\theta_{str} = (\Delta\theta_{str,1} + \Delta\theta_{str,2})/2 \ [K] \tag{B.1}$$

Temperature variation for intermittent operation:

controls $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \Delta\theta_{im,ctr} = 0{,}0$ K

emitters $\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \Delta\theta_{im,emt} = -0{,}3$ K

Temperature variation for radiation effect: $\quad \Delta\theta_{rad} = 0$ K

Alternatively, product specific values for $\Delta\theta_{rad}$ in accordance to product standards can be used.

Temperature variation for room automation:

stand alone[13] $\quad\quad\quad\quad\quad\quad\quad\quad\quad \Delta\theta_{roomaut} = -0{,}5$ K

stand alone with self-adoption start/stop[14] $\quad \Delta\theta_{roomaut} = -1{,}0$ K

networked with self-adoption and interaction[15] $\Delta\theta_{roomaut} = -1{,}2$ K

(Interaction in the form of individual room control system includes the connection of the individual room control system with additional controls and/or the heat source — for example, supply temperature adaptation.)

B.3 Temperature Variation for component integrated heating surfaces (panel heaters) (room heights ≤4 m, heating case)

In Table B.3 the temperature variation for component integrated heating surfaces (panel heaters) (room heights ≤ 4 m) are prescribed.

---

13) Standalone: app user interface to set weekly temperature schedules.

14) Standalone with self-adaption start/stop:
     — Individual adaptive start heating function during energy saving periods to ensure the comfort temperature is not reached before needed and programmed by the user.
    — Central away/home function common for all rooms.
    — Window open detection on one unit operates all actuator/controllers in the same room.

15) Networked with self-adaption and interaction:
    — System supply temperature adaption to lower (higher: cooling) levels depending on demand detected by room units.
    — System fault detection alarms on power loss (battery) and frost risk (room temperatures less than e.g. 5 °C).

Table B.3 — Default values for temperature variation for component integrated heating surfaces (panel heaters) in K; room heights ≤4 m; heating case

Influence parameters		Variation				
		$\Delta\theta_{str}$	$\Delta\theta_{ctr,1}$[a]	$\Delta\theta_{ctr,2}$[b]	$\Delta\theta_{emb}$	
Room space temperature regulation	Unregulated, with central supply temperature regulation		2,5	2,5		
	Master room space		2	1,8		
	Room temperature control (e.g. 2-step controller)		1,8	1,6		
	P-controller (before 1988)		1,4	1,4		
	P-controller/2-step controller (hysteresis ≤ ±0,5 K)		1,2	0,7		
	PI-controller		1,2	0,7		
	PI-controller (with optimisation function, e.g. presence management, adaptive controller)		0,9	0,5		
System	Floor heating				$\Delta\theta_{emb,1}$	$\Delta\theta_{emb,2}$
	— screed system	0			0,7	
	— dry system	0			0,4	
	— system with low cover	0			0,2	
	Wall heating	0,4			0,7	
	Ceiling heating	0,7			0,7	
	Heating systems combined with mechanical ventilation[c]	0				
Specific heat losses via laying surfaces	Integrated heating surface without minimum insulation in accordance with EN 1264-2					1,4
	Integrated heating surface with minimum insulation in accordance with EN 1264-2					0,5
	Integrated heating surface with 100 % better insulation than required by EN 1264-2					0,1

[a]   Use $\Delta\theta_{ctr,1}$ for not certified products.

[b]   Use $\Delta\theta_{ctr,2}$ for certified products.

[c]   When heating systems are installed in rooms equipped with mechanical ventilation systems the temperature stratification is influenced.

For $\Delta\theta_{emb}$ an average value is to be formed from the data for the main influence parameters "system" and "specific heat losses via laying surfaces".

$$\Delta\theta_{emb} = (\Delta\theta_{emb,1} + \Delta\theta_{emb,2})/2 \tag{B.2}$$

In Table B.4 the default values for overall temperature variation for thermally activated building systems (room heights ≤4 m) are prescribed.

Table B.4 — Default values for temperature variation for component integrated heating surfaces (thermally activated building systems) in K; room heights ≤4 m; heating case

Influence parameters		Variation $\Delta\theta$
Control	Constant supply temperature	3
	Central supply temperature regulation	2,7

Temperature variation for intermittent operation:

controls $\Delta\theta_{im,ctr} = 0,0$ K

emitters $\Delta\theta_{im,emt} = -0,2$K

Temperature variation for radiation effect: $\Delta\theta_{rad} = 0$ K

Alternatively, product specific values for $\Delta\theta_{rad}$ in accordance to product standards can be used.

Temperature variation for room/space automation:

stand alone[16] $\Delta\theta_{roomaut} = -0,5$ K

stand alone with self-adoption start/stop[17] $\Delta\theta_{roomaut} = -1,0$ K

networked with self-adoption and interaction[18] $\Delta\theta_{roomaut} = -1,2$ K

(Interaction in the form of individual room control system includes the connection of the individual room control system with additional controls and/or the heat source — for example, supply temperature adaptation.)

B.4 Temperature variation for air heating systems; room heights ≤4 m (heating case)

For air heating systems the calculation has to be done with the following values:

Air heating system (mixing case) $\Delta\theta_{str} = 0,0$ K

$\Delta\theta_{ctr,1}$ = according to Table B.2

$\Delta\theta_{ctr,2}$ = according to Table B.2

$\Delta\theta_{emb} = 0$K

Temperature variation for intermittent operation:

controls $\Delta\theta_{im,ctr} = 0,0$ K

emitters $\Delta\theta_{im,emt} = 0,0$ K

Temperature variation for radiation effect: $\Delta\theta_{rad} = 0$ K

Temperature variation for room automation:

stand alone[19] $\Delta\theta_{roomaut} = -0,5$ K

---

16) Standalone: app user interface to set weekly temperature schedules

17) Standalone with self-adaption start/stop:
   — Individual adaptive start heating function during energy saving periods to ensure the comfort temperature is not reached before needed and programmed by the user.
   — Central away/home function common for all rooms.
   — Window open detection on one unit operates all actuator/controllers in the same room.

18) Networked with self-adaption and interaction:
   — System supply temperature adaption to lower (higher: cooling) levels depending on demand detected by room units.
   — System fault detection alarms on power loss (battery) and frost risk (room temperatures less than e.g. 5 °C).

19) Standalone: app user interface to set weekly temperature schedules.

stand alone with self-adoption start/stop[20] $\Delta\theta_{\text{roomaut}}$ = −1,0 K

networked with self-adoption and interaction[21] $\Delta\theta_{\text{roomaut}}$ = −1,2 K

(Interaction in the form of individual room control system includes the connection of the individual room control system with additional controls and/or the heat source — for example, supply temperature adaptation.)

B.5 Temperature variation for electrical heating (room heights ≤4 m, heating case)

In Table B.5 the default values for temperature variation for electrical heating (room heights ≤ 4 m) are prescribed.

Table B.5 — Temperature variation for electrical heating and air heating systems in K (room heights ≤4 m, heating case)

Influence parameters		Variation $\Delta\theta$
External wall region	Air heating with zone control P-controller (1 K)	1,2
	Air heating with central master control and pilot room control including supplementary heating with single-room control P-controller (1K)	1,1
	E-direct heating P-controller (1 K) or air heating with single-room control P-controller (1 K)	1,1
	E-direct heating PI-controller (with optimization) or air heating with single-room control PI-controller (with optimization)	0,7
	Storage heating unregulated without external temperature dependent charging	2,7
	Storage heating P-controller (1 K) with external temperature dependent charging	1,5
	Storage heating PID-controller with optimization with external temperature dependent charging	1,1
Internal wall region	Air heating with zone control P-controller (1 K)	1,6
	Air heating with central master control and pilot room control including supplementary heating with single-room control P-controller (1K)	1,5
	E-direct heating P-controller (1 K) or air heating with single-room control P-controller (1 K)	1,5
	E-direct heating PI-controller (with optimization) or air heating with single-room control PI-controller (with optimization)	1,1
	Storage heating unregulated without external temperature dependent charging	3,1
	Storage heating P-controller (1 K) with external temperature dependent charging	1,9
	Storage heating PID-controller with optimization with external temperature dependent charging	1,5
Ventilation systems with supply air temperature below the room temperature		0,0

Temperature variation for intermittent operation: $\Delta\theta_{\text{im}}$ = −0,3 K (to be used for electrical heating systems with an integrated feedback control system)

Temperature variation for radiation effect: $\Delta\theta_{\text{rad}}$ = 0 K

---

20) Standalone with self-adaption start/stop:
— Individual adaptive start heating function during energy saving periods to ensure the comfort temperature is not reached before needed and programmed by the user.
— Central away/home function common for all rooms.
— Window open detection on one unit operates all actuator/controllers in the same room.

21) Networked with self-adaption and interaction:
— System supply temperature adaption to lower (higher: cooling) levels depending on demand detected by room units.
— System fault detection alarms on power loss (battery) and frost risk (room temperatures less than e.g. 5 °C).

Alternatively, product specific values for $\Delta\theta_{rad}$ in accordance to product standards can be used.

B.6 Temperature variation air heating (ventilation systems, room heights ≤4 m, heating case)

In Table B.6 the default values for temperature variation $\Delta\theta$ for air heating (non-domestic ventilation systems) (room heights ≤4 m) are prescribed.

Table B.6 — Default values for temperature variation for air heating (ventilation systems) in K; room heights ≤4 m; heating case

System configuration	Control parameter	$\Delta\theta$	
		Low quality of control	High quality of control
Additional heating in the incoming air (additional heater)	Room space temperature	1,8	1,3
	Room space temperature (cascade control of incoming air temperature)	1,2	1,0
	Exhaust air temperature	1,9	1,5
Recirculation air heating (induction equipment, ventilator convectors, fan coil units)	Room space temperature	1,1	0,7

Temperature variation intermittent operation: $\Delta\theta_{im}$ = 0 K

Temperature variation for radiation effect: $\Delta\theta_{rad}$ = 0 K

B.7 Temperature variation for room spaces with heights >4 m (large indoor space buildings, heating case)

In Table B.7 the default values for temperature variation for room spaces with heights ≥4 m are prescribed.

Table B.7 — Default values for temperature variation for room spaces with heights >4 m in K; heating case (Reference case: ceiling height 10 m, standard product values radiant factors of luminous and tube heaters)

Influence parameters			Variation		
			$\Delta\theta_{ctr,1}$ [a]	$\Delta\theta_{ctr,2}$ [b]	$\Delta\theta_{emb}$
Room space temp. regulation	Unregulated		2,5	2,5	
	Two-step controller		1,8	1,6	
	P-controller		1,2	0,7	
	PI-controller		1,2	0,7	
	PI-controller with optimisation		0,9	0,5	
[a] Use $\Delta\theta_{ctr,1}$ for not certified products.					
[b] Use $\Delta\theta_{ctr,2}$ for certified products.					
[c] The outcoming temperature has to be max. 15 K higher than the required internal temperature; the value $\Delta\theta_{str}$ = 1,03 may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str}$ = 2,93 has to be used.					
[d] The outcoming temperature has to be max. 15 K higher than the required internal temperature; the value $\Delta\theta_{str}$ = 1,03 may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str}$ = 1,76 has to be used.					

Table B.7 *(continued)*

Influence parameters			Variation		
			$\Delta\theta_{ctr,1}$ [a]	$\Delta\theta_{ctr,2}$ [b]	$\Delta\theta_{emb}$
	Warm air without additional vertical recirculation	Outlet horizontal (wall unit)			0
		Outlet horizontal (wall unit) low temperature system[c] (valid only up to ceiling heights of 6 m)			0
		Outlet from above (ceiling unit)			0
		Outlet from vertical (ceiling unit) low temperature system[d] (valid only up to ceiling heights of 6 m)			0
	Warm air with additional vertical recirculation or adjustable induction outlet	Recirculation controlled by two-step controller			0
		Recirculation controlled by PI-controller			0
	Radiant tube heaters	Standard design			0
		Improved design			0
	Luminous heaters	Standard design			0
		Improved design			0
	Radiant ceiling panels	Standard design			0,5
		Improved design			0,3
		Improved design and keeping distances to the wall			0
	Floor heating	Without isolation (coverage ≤10 cm)			1,4
		Without isolation (coverage >10 cm)			1,9
		Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage ≤10 cm)]			0,5
		Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage >10 cm)]			1,0
		Thermally decoupled [$U_{bottom\ plate} \le 0,35$ W/(m^{2}K)] and coverage ≤10 cm			0

[a]   Use $\Delta\theta_{ctr,1}$ for not certified products.

[b]   Use $\Delta\theta_{ctr,2}$ for certified products.

[c]   The outcoming temperature has to be max. 15 K higher than the required internal temperature; the value $\Delta\theta_{str} = 1,03$ may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str} = 2,93$ has to be used.

[d]   The outcoming temperature has to be max. 15 K higher than the required internal temperature; the value $\Delta\theta_{str} = 1,03$ may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str} = 1,76$ has to be used.

Table B.8 — Air temperature gradient for rooms with ceilings heights >4 m

Emitter system		Air temperature gradient θ'_{str} [K/m]
Warm air heaters with-out additional vertical recirculation	Outlet horizontal (wall unit)	1,0
	Outlet horizontal (wall unit) low temperature system[c] (valid only up to ceiling heights of 6 m)	0,35
	Outlet from above (ceiling unit)	0,60
	Outlet from above (ceiling unit) low temperature system[d] (valid only up to ceiling heights of 6 m)	0,35
Warm air heaters with additional vertical recir-culation	Recirculation controlled by two-step controller	0,35
	Recirculation controlled by PI-controller	0,25
Radiant tube heaters	Standard design	0,2
	Improved design[a]	0,2
Luminous heaters	Standard design	0,2
	Improved design[b]	0,2
Radiant ceiling panels	Standard design	0,4
	Improved design	0,3
	Improved design and keeping distances to the wall	0,3
Floor heating	Without isolation (coverage ≤10 cm)	0,1
	Without isolation (coverage >10 cm)	0,1
	Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage ≤10 cm)]	0,1
	Integrated into the component [minimum insulation in accordance with EN 1264-2 (coverage >10 cm)]	0,1
	Thermally decoupled [$U_{bottom\ plate} \le 0{,}35\ W/(m^2K)$] and coverage ≤10 cm	0,1

[a]   Improved design radiant tube heaters:
feature construction with completely insulated reflector; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according to. EN 416 shall be minimum 0,69.

[b]   Improved design radiant luminous heaters:
feature construction with reflector over streamed by flue gases; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according toEN 419 shall be minimum 0,69.

[c]   The outcoming temperature has to be max. 15 K higher than the required internal temperature; the value $\Delta\theta_{str} = 1{,}03$ may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str} = 2{,}93$ has to be used.

[d]   The outcoming temperature has to be max. 15 K higher than the required internal temperature; the value $\Delta\theta_{str} = 1{,}03$ may only be used for ceiling heights ≤6 m. For larger ceiling heights the value $\Delta\theta_{str} = 1{,}76$ has to be used.

Table B.9 — Standard product values of radiant factors for radiant luminous and radiant tube heaters in rooms with ceiling heights >4 m

Heater	Classification	RF
Radiant tube heater	Standard	0,55
	Improved design[a]	0,69

[a]   Improved design radiant tube heaters:
feature construction with completely insulated reflector; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according to. EN 416 shall be minimum 0,69.

[b]   Improved design radiant luminous heaters:
feature construction with reflector over streamed by flue gases; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according toEN 419 shall be minimum 0,69.

Table B.9 *(continued)*

Heater	Classification	RF
Radiant luminous heaters	Standard	0,55
	Improved design[b]	0,69

a	Improved design radiant tube heaters: feature construction with completely insulated reflector; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according to. EN 416 shall be minimum 0,69.
b	Improved design radiant luminous heaters: feature construction with reflector over streamed by flue gases; in case value for "improved design" is used for heat demand calculation, the product value for radiant factor RF according toEN 419 shall be minimum 0,69.

B.8 Temperature variation for room heaters fired by solid fuel

In Table B.10 the temperature variation for room heaters fired by solid fuel are prescribed.

Table B.10 — Temperature variation for room heaters fired by solid fuel

Influence parameters		Variation		
		$\Delta\theta_{str}$	$\Delta\theta_{ctrl,1}$	$\Delta\theta_{ctrl,2}$
System	Used on one single floor	0,9		
	Used for 2 floors	1,4		
Control	Manual thermostat		2,5	2,5
	Room thermostat		2	2

B.9 Temperature variation for water-based cooling systems; room heights ≤4 m (cooling case)

Table B.11 — Temperature variation for cooling systems; room heights ≤4 m (cooling case)

Influence parameters		Variation			
		$\Delta\theta_{str}$	$\Delta\theta_{ctr,1}$[a]	$\Delta\theta_{ctr,2}$[b]	$\Delta\theta_{emb}$
Room space emperature regulation	Unregulated, with central supply temperature regulation		−2,5	−2,5	
	Master room space or one-pipe heating		−2	−1,8	
	Room temperature control (electromechanical/electronic)		−1,8	−1,6	
	P-controller (before 1988)		−1,4	−1,4	
	P-controller		−1,2	−0,7	
	PI-controller		−1,2	−0,7	
	PI-controller (with optimisation function, e.g. presence management, adaptive controller)		−0,9	−0,5	

a	Use $\Delta\theta_{ctr,1}$ for not certified products.
b	Use $\Delta\theta_{ctr,2}$ for certified products.