INTERNATIONAL STANDARD

ISO 11855-7

First edition
2019-09

Building environment design — Design, dimensioning, installation and control of embedded radiant heating and cooling systems —

Part 7: Input parameters for the energy calculation

Conception de l'environnement des bâtiments — Conception, dimensionnement, installation et contrôle des systèmes radiants encastrés de chauffage et de refroidissement —

Partie 7: Paramètres d'entrée pour le calcul de la performance énergétique

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Reference number
ISO 11855-7:2019(E)

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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).

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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*.

A list of all parts in the ISO 11855 series can be found on the ISO website.

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.

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Introduction

The radiant heating and cooling system consists of heat emitting/absorbing, heat supply, distribution and control systems. The ISO 11855 series deals with the embedded surface heating and cooling system that directly controls heat exchange within the space. It does not include the system equipment itself, such as heat source, distribution system and controller.

The ISO 11855 series addresses an embedded system that is integrated with the building structure. Therefore, the panel system with open air gap, which is not integrated with the building structure, is not covered by this series.

The ISO 11855 series is intended to be applied to systems using not only water but also other fluids or electricity as a heating or cooling medium.

The object of the ISO 11855 series is to provide criteria to effectively design embedded systems. To do this, it presents comfort criteria for the space served by embedded systems, heat output calculation, dimensioning, dynamic analysis, installation, operation and control method of embedded systems.

The ISO 11855 series consists of the following:

— Part 1 specifies the comfort criteria which should be considered in designing embedded radiant heating and cooling systems, since the main objective of the radiant heating and cooling system is to satisfy thermal comfort of the occupants.

— Part 2 provides steady-state calculation methods for determination of the heating and cooling capacity.

— Part 3 specifies design and dimensioning methods of radiant heating and cooling systems to ensure the heating and cooling capacity.

— Part 4 provides a dimensioning and calculation method to design Thermo Active Building Systems (TABS) for energy-saving purposes, since radiant heating and cooling systems can reduce energy consumption and heat source size by using renewable energy.

— Part 5 addresses the installation process for the system to operate as intended.

— Part 6 shows a proper control method of the radiant heating and cooling systems to ensure the maximum performance which was intended in the design stage when the system is actually being operated in a building.

— Part 7 presents a calculation method for the product specific input parameters for ISO 52031[1)].

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1) Under preparation. Stage at time of publication: ISO/DIS 52031:2019.

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Building environment design — Design, dimensioning, installation and control of embedded radiant heating and cooling systems —

Part 7: Input parameters for the energy calculation

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1 Scope

This document specifies procedures and conditions to enable the heat flow in water-based and electrical surface heating and cooling systems to be determined relative to the medium differential temperature for systems. The determination of thermal performance of water-based surface heating and cooling systems and their conformity to this document is carried out by calculation in accordance with design documents and a model. This enables a uniform assessment and calculation of water-based surface heating and cooling systems.

The surface temperature and the temperature uniformity of the heated/cooled surface, nominal heat flow density between water or electrical heated layer and space, the associated nominal medium differential temperature, and the field of characteristic curves for the relationship between heat flow density and the determining variables are given as the result.

This document is applicable to water-based embedded surface heating and cooling systems in residential, commercial and industrial buildings. This document is also applicable for electrical heated embedded systems. The methods apply to systems integrated into the wall, floor or ceiling construction without any open air gaps. It does not apply to ceiling mounted panel systems with open air gaps which are not integrated into the building structure.

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 11855-1, *Building environment design — Design, dimensioning, installation and control of embedded radiant heating and cooling systems — Part 1: Definition, symbols, and comfort criteria*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11855-1 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/

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4 Symbols

4.1 Symbols

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

Symbol	Quantity	Unit
$\Delta\theta_{ctr}$	Temperature variation based on room control system	K
$\Delta\theta_{ctr,1}$	temperature variation based on room control system, not certified products	K
$\Delta\theta_{ctr,2}$	temperature variation based on room control system, certified products	K
$\Delta\theta_{hydr}$	temperature variation based on not balanced hydraulic systems	K
$\Delta\theta_{im,crt}$	temperature variation based on intermittent room controls operation system	K
$\Delta\theta_{im,emt}$	temperature variation based on intermittent operation of the emission system	K
$\Delta\theta_{rad}$	temperature variation based on radiation by type of the emission system	K
$\Delta\theta_{str}$	temperature variation based on the stratification	K
$\Delta\theta_{str,1}$	temperature variation based on the stratification - part of influence due to "over-temperature"	K
$\Delta\theta_{str,2}$	temperature variation based on the stratification - part of influence due to "specific heat losses via external components"	K
$\Delta\theta_{emb}$	temperature variation based on an additional heating / cooling loss by emitters embedded in the envelope	K
$\Delta\theta_{roomout}$	temperature variation based on room automation	K
c_i	specific heat capacity of the layer	kJ/(kg K)
ρ_i	density of the of the layer	kg/m^3
d_i	thickness of the layer	m
q_{Ref}	specific power of a reference system according to ISO 11855-2	kW/m^2
C_{sys}	specific heat capacity of the system	kJ / (m^2·K)
A	coefficient of the calculation	(K^2 m^2)/kJ
B	coefficient of the calculation	K

4.2 Subscripts

For the purposes of this document, the symbols are in accordance with ISO 52000 and the following subscripts 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 Basic formula

ISO 52031 presents an overall calculation method for the additional heat losses and energy efficiency. The calculation procedure in ISO 52031 is based on temperature differences (temperature variations). The following formulae are used:

The equivalent internal temperature, $\theta_{int,inc}$, taking into account the emitter, is calculated by using Formulae (1) and (2).

$$\theta_{int,inc} = \theta_{int,ini} + \Delta\theta_{int,inc} \quad (1)$$

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$$\Delta\theta_{int,inc} = \Delta\theta_{str} + \Delta\theta_{ctr} + \Delta\theta_{emb} + \Delta\theta_{rad} + \Delta\theta_{im} + \Delta\theta_{hydr} + \Delta\theta_{roomaut} \quad (2)$$

With temperature variation based on emission system:

$$\Delta\theta_{emt,syst} = \Delta\theta_{str} + \Delta\theta_{emb} + \Delta\theta_{rad} + \Delta\theta_{im,emt} \quad (3)$$

In Formula (3) $\Delta\theta_{rad}$ is calculated for radiators, and $\Delta\theta_{im,emt}$ is calculated for embedded systems in this document (see Clause 6).

And with temperature variation based on control system calculated by using Formula (4):

$$\Delta\theta_{ctr,syst} = \Delta\theta_{ctr} + \Delta\theta_{im,ctr} + \Delta\theta_{roomaut} \quad (4)$$

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

The equivalent internal temperature difference, $\theta_{int,inc}$, taking into account the emitter, is calculated by using Formula (5):

$$\Delta\theta_{int,inc} = \Delta\theta_{hydr} + \Delta\theta_{emt,syst} + \Delta\theta_{ctr,syst} \quad (5)$$

Based on these formulae the following chapter describes some calculation methods for the input parameters[2)].

6 Determination of input parameters for the energy efficiency of heating and cooling emission systems

The following describes the determination procedure for the different products. The calculation procedure is for embedded surface heating systems. For a calculation example see Annex A.

The correction of the default values, given in ISO 52031, is based on the specific heat capacity of the system. The specific heat capacity can be calculated as follows:

$$C_{sys} = \sum_{i=l}^{n} c_i \cdot \rho_i \cdot d_i \quad (6)$$

All layers above the insulation shall be considered as layers. Pipe material as well as the water in the pipes is not taken into account in the calculation.

With C_{sys} the correction coefficient can be calculated depend on the orientation of the embedded heating surface as follows:

$$\Delta\theta_{im,emt} = A \cdot C_{sys} + B \quad (7)$$

For the heating and cooling case the different values for the coefficients A and B can be selected from Table 1.

2) Additional information can be found in the literature listed in the Bibliography (see References [4] to [10]).

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Table 1 — Coefficient *A* and *B* depend on the orientation of the embedded system (heating and cooling case)

Installation of the system	Heating case		Cooling case	
	A $(K^2m^2)/kJ$	*B* K	*A* $(K^2m^2)/kJ$	*B* K
Ceiling	0,037	−1,45	−0,037	1,44
Floor	0,001 9	−0,29	−0,005	0,74
Wall	0,098	−3,86	−0,037	1,44
Wall with additional insulation	0,079	−3,12	−0,018	0,72
NOTE The coefficients *A* and *B* are based on numerical simulations. Detailed information is given in Formulae [6] and [7].				

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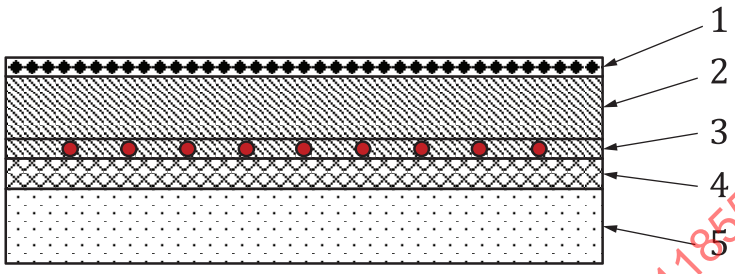
Annex A
(informative)

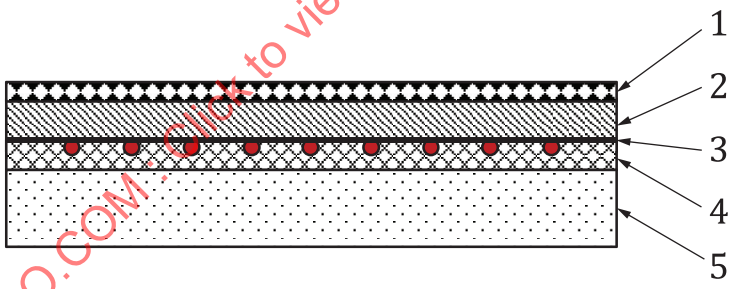
Calculation example



Key

1 tile (c_1, ρ_1, d_1)
2 weight distribution layer (c_2, ρ_2, d_2)
3 weight distribution layer (c_3, ρ_3, d_3)
4 thermal insulation
5 ceiling construction

Figure A.1 — Construction of typical floor heating systems — Wet system (type A or C)



Key

1 tile (c_1, ρ_1, d_1)
2 weight distribution layer (c_2, ρ_2, d_2)
3 weight conductivity installation (c_3, ρ_3, d_3) (aluminium sheet)
4 thermal insulation
5 ceiling construction

Figure A.2 — Construction of typical floor heating systems — Dry system (type B)

Table A.1 gives details of the wet and dry systems.

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