EESTI STANDARD

EVS-EN ISO 11855-3:2015

Building environment design - Design, dimensioning, installation and control of embedded radiant heating and cooling systems - Part 3: Design and dimensioning (ISO 11855-3:2012)

EESTI STANDARDIKESKUS
ESTONIAN CENTRE FOR STANDARDISATION

EESTI STANDARDI EESSÕNA / NATIONAL FOREWORD

See Eesti standard EVS-EN ISO 11855-3:2015 sisaldab Euroopa standardi EN ISO 11855-3:2015 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 11855-3:2015 consists of the English text of the European standard EN ISO 11855-3:2015.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 05.08.2015.	Date of Availability of the European standard is 05.08.2015.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 91.140.10, 91.140.30

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 11855-3

August 2015

ICS 91.140.10; 91.140.30

English Version

Building environment design - Design, dimensioning, installation and control of embedded radiant heating and cooling systems - Part 3: Design and dimensioning (ISO 11855-3:2012)

Conception de l'environnement des bâtiments - Normes pour la conception, la construction et le fonctionnement des systèmes de chauffage et de refroidissement par rayonnement - Partie 3: Conception et dimensionnement (ISO 11855-3:2012)

Umweltgerechte Gebäudeplanung - Planung, Auslegung, Installation und Steuerung flächenintegrierter Strahlheizungs- und -kühlsysteme - Teil 3: Planung und Auslegung (ISO 11855-3:2012)

This European Standard was approved by CEN on 30 July 2015.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN ISO 11855-3:2015 E

European foreword

The text of ISO 11855-3:2012 has been prepared by Technical Committee ISO/TC 205 “Building environment design” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 11855-3:2015 by Technical Committee CEN/TC 228 “Heating systems and water based cooling systems in buildings” the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2016, and conflicting national standards shall be withdrawn at the latest by February 2016.

This standard is applicable for design, construction and operation of radiant heating and cooling systems. The methods defined in part 2 are intended to determine the design heating or cooling capacity used for the design and evaluation of the performance of the system.
For identifying product characteristics by testing and proving the thermal output of heating and cooling surfaces embedded in floors, ceilings and walls the standard series EN 1264 can be used.

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

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 11855-3:2012 has been approved by CEN as EN ISO 11855-3:2015 without any modification.

Contents

Page

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 shall 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.

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

Part 3: Design and dimensioning

1 Scope

This part of ISO 11855 establishes a system design and dimensioning method to ensure the heating and cooling capacity of the radiant heating and cooling systems.

The ISO 11855 series is applicable to water based embedded surface heating and cooling systems in residential, commercial and industrial buildings. The methods apply to systems integrated into the wall, floor or ceiling construction without any open air gaps. It does not apply to panel systems with open air gaps which are not integrated into the building structure.

The ISO 11855 series applies also, as appropriate, to the use of fluids other than water as a heating or cooling medium. The ISO 11855 series is not applicable for testing of systems. The methods do not apply to heated or chilled ceiling panels or beams.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 12831, *Heating systems in buildings — Method for calculation of the design heat load*

EN 15243, *Ventilation for buildings — Calculation of room temperatures and of load and energy for buildings with room conditioning systems*

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*

ISO 11855-2, *Building environment design — Design, dimensioning, installation and control of embedded radiant heating and cooling systems — Part 2: Determination of the design heating and cooling capacity*

3 Terms and definitions

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

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviations in Table 1 apply.

Table 1 — Symbols and abbreviated terms

Symbol	Unit	Quantity
A_F	m^2	Area of the heating/cooling surface

Table 1 *(continued)*

Symbol	Unit	Quantity
A_A	m^2	Area of the occupied heating/cooling surface
A_R	m^2	Area of the peripheral heating/cooling surface
c_W	J/(kg·K)	Specific heat of medium
K_H	W/(m²·K)	Equivalent heat transmission coefficient
l_p	m	Distance between the joists
l_W	m	Thickness of the joist
M	kg/s	Design heating/cooling medium flow rate
q_{des}	W/m²	Design heat flux
$q_{des,A}$	W/m²	Design heat flux in the occupied area
$q_{des,R}$	W/m²	Design heat flux in the peripheral area
q_G	W/m²	Limit heat flux
q_{max}	W/m²	Maximum design heat flux
Q_{des}	W	Design heating/cooling capacity
Q_N	W	Design heating/cooling load
$Q_{N,s}$	W	Design sensible cooling load
$Q_{N,l}$	W	Design latent cooling load
Q_{out}	W	Heat output of supplementary heating equipment
R_o	(m² K)/W	Partial inwards heat transmission resistance of the surface structure
R_u	(m² K)/W	Partial outwards heat transmission resistance of the surface structure
$R\lambda_{,B}$	(m²·K)/W	Thermal resistance of surface covering
$R\lambda_{,ins}$	(m²·K)/W	Back side thermal resistance of insulating layer
s_{ins}	m	Effective thickness of thermal insulating layer
W	m	Pipe spacing
h	W/(m² K)	Heat transfer coefficient
λ_{ins}	W/(m·K)	Effective thermal conductivity of the thermal insulation layer
λ_i	W/(mK)	Thermal conductivity of the thermal insulation layer between the joists
λ_w	W/(mK)	Thermal conductivity of the joist
$\theta_{F,max}$	°C	Maximum surface temperature
$\theta_{F,min}$	°C	Minimum surface temperature
θ_i	°C	Design indoor temperature
θ_R	°C	Return temperature of heating/cooling medium
θ_V	°C	Supply temperature of heating/cooling medium
$\theta_{V,des}$	°C	Design supply temperature of heating/cooling medium
$\Delta\theta_H$	K	Heating/cooling medium differential temperature
$\Delta\theta_{H,des}$	K	Design heating/cooling medium differential temperature
$\Delta\theta_{H,G}$	K	Limit of heating/cooling medium differential temperature
$\Delta\theta_{V,des}$	K	Design heating/cooling medium differential supply temperature
σ	K	Temperature drop/rise between supply and return medium

5 Radiant panel

5.1 Floor heating systems

5.1.1 Design procedure

Floor heating system design requires determining heating surface area, type, pipe size, pipe spacing, supply temperature of the heating medium, and design heating medium flow rate. The design steps are as follows:

Step 1: Calculate the design heating load Q_N. The design heating load Q_N shall not include the adjacent heat losses. This step should be conducted in accordance with a standard for heating load calculation, such as EN 12831, based on an index such as operative temperature (OT) (see ISO 11855-1).

Step 2: Determine the area of the heating surface A_F, excluding any area covered by immovable objects or objects fixed to the building structure.

Step 3: Establish a maximum permissible surface temperature in accordance with ISO 11855-1.

Step 4: Determine the design heat flux q_{des} according to Equation (1). For floor heating systems including a peripheral area, the design heat flux of peripheral area $q_{des,R}$ and the design heat flux of occupied area $q_{des,A}$ shall be calculated respectively on the area of the peripheral heating surface A_R and on the area of the occupied heating surface A_A complying with Equation (2).

$$q_{des} = \frac{Q_N}{A_F} \tag{1}$$

$$Q_N = q_{des,R} \cdot A_R + q_{des,A} \cdot A_A \tag{2}$$

Step 5: For the design of the floor heating systems, determine the room used for design with the maximum design heat flux $q_{max} = q_{des}$.

Step 6: Determine the floor heating system such as the pipe spacing and the covering type, and design heating medium differential temperature $\Delta\theta_{H,des}$ based on the maximum design heat flux q_{max} and the maximum surface temperature $\theta_{F,max}$ from the field of characteristic curves according to ISO 11855-2 and 5.1.7 in this part of ISO 11855.

Step 7: If the design heat flux q_{des} cannot be obtained by any pipe spacing for the room used for the design, it is recommended to include a peripheral area and/or to provide supplementary heating equipment. In this case, the maximum design heat flux q_{max} for the embedded system may now occur in another room. The amount of heat output of supplementary heating equipment Q_{out} is determined by the following equation:

$$Q_{out} = Q_N - Q_{des} \tag{3}$$

where design heating capacity Q_{des} is calculated by:

$$Q_{des} = q_{des} \times A_F \tag{4}$$

Step 8: Determine the backside thermal resistance of insulating layer $R_{\lambda,ins}$ and the design heating medium flow rate m (see 5.1.6 and 5.1.8).

Step 9: Estimate the total length of heating circuit.

If intermittent operation is common, the characteristics of the increase of the heat flow and the surface temperature and the time to reach the allowable conditions in rooms just after switching on the system shall be considered.

5.1.2 Heating medium differential temperature

Heating medium differential temperature $\Delta\theta_H$ is calculated as follows (refer to ISO 11855-2):

$$\Delta\theta_H = \frac{\theta_V - \theta_R}{\ln \dfrac{\theta_V - \theta_i}{\theta_R - \theta_i}} \tag{5}$$

In this equation, the effect of the temperature drop of the heating medium is taken into account.

5.1.3 Characteristic curve

The characteristic curve describes the relationship between the heat flux q and the heating medium differential temperature $\Delta\theta_H$. For simplicity, the heat flux q is taken to be proportional to the heating medium differential temperature $\Delta\theta_H$:

$$q = K_H \cdot \Delta\theta_H \tag{6}$$

where K_H is the equivalent heat transmission coefficient determined in ISO 11855-2 depending on the type of the system.a

5.1.4 Field of characteristic curves

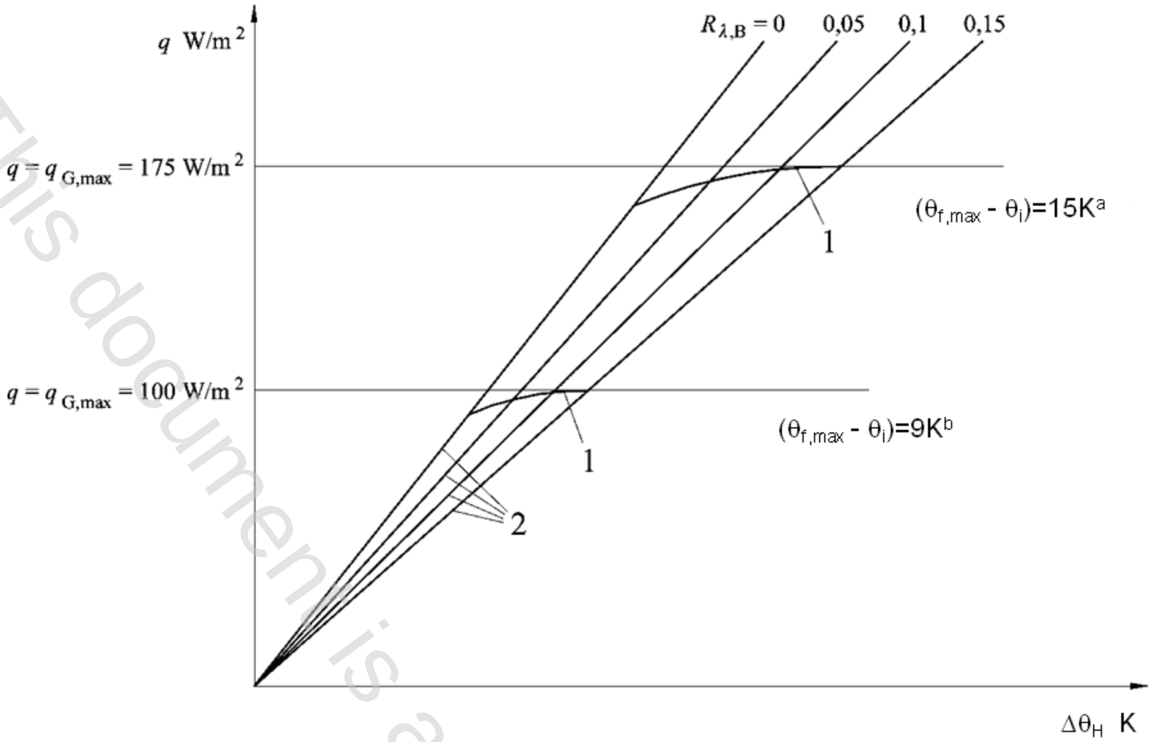
The field of characteristic curves of a floor heating system with a specific pipe spacing W shall at least contain the characteristic curves for values of the thermal resistance of surface covering $R_{\lambda,B}$ = 0, $R_{\lambda,B}$ = 0,05, $R_{\lambda,B}$ = 0,10 and $R_{\lambda,B}$ = 0,15 (m²K/W), in accordance with ISO 11855-2 (see Figure 1). Values of $R_{\lambda,B}$ > 0,15 (m²K/W) shall not be used if possible.

5.1.5 Limit curves

The limit curves in the field of characteristic curves describe, in accordance with ISO 11855-2, the relationship between the heating medium differential temperature $\Delta\theta_H$ and the heat flux q in the case where the physiologically agreed limit values of surface temperatures are reached. For design purposes, i.e. the determination of design values of the heat flux and the associated heating medium differential temperature $\Delta\theta$, the limit curves are valid for temperature drop between supply and return medium σ in a range of:

$$0\ \mathrm{K} < \sigma < 5\ \mathrm{K} \tag{7}$$

The limit curves are used to specify the limit of heating medium differential temperature $\Delta\theta_{H,G}$ and supply temperature (refer to Figure 6).



Key

1 limit curves

2 performance characteristic curves

[a] Peripheral area.

[b] Occupied area.

Figure 1 — Field of characteristic curves, including limit curves for floor heating, for constant pipe spacing

This example is for floor heating, indoor temperature = 20 °C and the maximum temperature is 29 °C (occupied areas) and 35 °C (peripheral area). For bathrooms (the indoor temperature is 24 °C), the limit curve for ($\theta_{F,max} - \theta_i$) = 9K also applies.

5.1.6 Downwards thermal insulation

In order to limit the heat flow through the floor towards the space below, the required back side thermal resistance of the insulating layer $R_{\lambda,ins}$ shall be specified in the design to be not lower than the value in Table 2 in ISO 11855-4:2012.

For systems which have a flat insulating layer (Types A, B, C, D and G in ISO 11855-2), the back-side thermal resistance of the insulating layer $R_{\lambda,ins}$ is calculated by Equation (8).

$$R_{\lambda,ins} = \frac{s_{ins}}{\lambda_{ins}} \tag{8}$$

Depending on the construction of the floor heating system, the effective thickness of thermal insulating layer s_{ins} and effective thermal conductivity of the thermal insulation layer λ_{ins} are determined differently.

For floor heating systems with flat thermal insulating panels of types A and C in ISO 11855-2:2012, the effective thickness of thermal insulating layer s_{ins} is identical to the thickness of the thermal insulation, and the effective thermal conductivity of the thermal insulation layer λ_{ins} is identical to the thermal conductivity of the thermal insulation [Figure 2 a)].

For the system with profiled thermal insulating panels of type B in ISO 11855-2:2012 [Figure 2 b)], the effective thickness of the insulating layer shall be determined by Equation (9).

$$s_{\text{ins}} = \frac{s_{\text{h}} \cdot (W - D) + s_{\text{l}} \cdot D}{W} \qquad (9)$$

For the system with the light wooden radiant panel on the joist of type G in ISO 11855-2:2012 [Figure 2 c)], the effective thickness of thermal insulating layer s_{ins} is identical to the thickness of the thermal insulating panel, and the effective thermal conductivity of the thermal insulation layer λ_{ins} is:

$$\lambda_{\text{ins}} = \lambda_{\text{i}} \frac{l_{\text{p}} - l_{\text{w}}}{l_{\text{p}}} + \lambda_{\text{w}} \frac{l_{\text{w}}}{l_{\text{p}}} \qquad (10)$$

where:

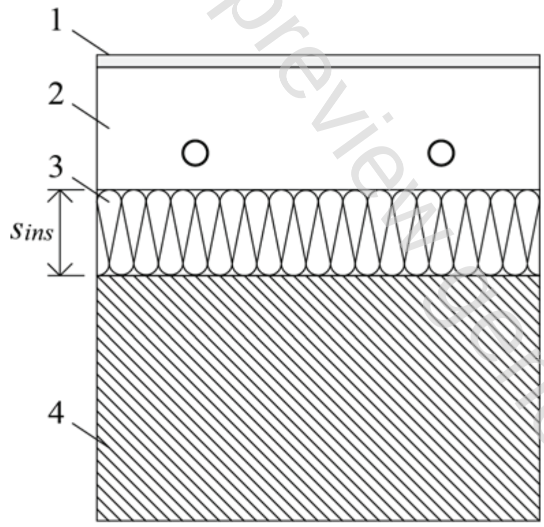
λ_{i} is thermal conductivity of the thermal insulation layer between the joists;

λ_{w} is thermal conductivity of the joist;

l_{p} is the distance between the joist (see Figure 5);

l_{w} is the thickness of the joist (see Figure 5).

For type G systems with air cavities see Annex C and E in ISO 11855-2:2012.



Key

1 floor covering
2 weight bearing and thermal diffusion layer (cement, anhydrite, or asphalt screed)
3 thermal insulation
4 structural bearing

Figure 2 — Effective thickness and effective thermal conductivity of thermal insulating layer of flat thermal insulating panel — Types A and C

