INTERNATIONAL STANDARD

ISO 11855-2

Second edition
2021-09

AMENDMENT 1
2023-11

Building environment design — Embedded radiant heating and cooling systems —

Part 2: Determination of the design heating and cooling capacity

AMENDMENT 1

Conception de l'environnement des bâtiments — Systèmes intégrés de chauffage et de refroidissement par rayonnement —

Partie 2: Détermination de la puissance calorifique et frigorifique à la conception

AMENDEMENT 1

Reference number
ISO 11855-2:2021/Amd.1:2023(E)

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This document was prepared by Technical Committee ISO/TC 205, *Building environment design*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 228, *Heating systems and water based cooling systems in buildings,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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Building environment design — Embedded radiant heating and cooling systems —

Part 2: Determination of the design heating and cooling capacity

AMENDMENT 1

Clause 4, Table 1

Modify the following rows:

Table 1 — Symbols

Symbol	Unit	Quantity
s_h	m	In system type II, thickness of thermal insulation from the outward edge of the insulation to the inward edge of the pipes (see Figure 2)
s_l	m	In system type II, thickness of thermal insulation from the outward edge of the insulation to the outward edge of the pipes (see Figure 2)
S	m	Thickness of the screed (excluding the pipes in system type I)

Clause 7, second paragraph

Modify to the following:

A given system construction can only be calculated with one of the simplified methods. The correct method to apply depends on the system type I to IV (position of pipes, concrete or wooden construction) and the boundary conditions listed in Table 2.

Delete the NOTE.

Table 2

Modify to the following:

Table 2 — Criteria for selection of simplified calculation method

Pipe position	New system type	Old system type	Figure	Boundary conditions	Reference to method
In screed Thermally decoupled from the structural base of the building by thermal insulation	I	A, C, H, I, J	2 a)	$W \geq 0{,}050$ m $s_u \geq 0{,}01$ m $0{,}008$ m $\leq d \leq 0{,}03$ m $s_u/\lambda_e \geq 0{,}01$	7.1 A.2.2
In insulation, conductive devices Not wooden constructions except for weight bearing and thermal diffusion layer	II	B	2 b)	$0{,}05$ m $\leq W \leq 0{,}45$ m $0{,}014$ m $\leq d \leq 0{,}022$ m $0{,}01$ m $\leq s_u/\lambda_e \leq 0{,}18$ m	7.1 A.2.3

Table 2 *(continued)*

Pipe position	New system type	Old system type	Figure	Boundary conditions	Reference to method
In concrete slab	V	E	4	$S_T / W \geq 0{,}3$	7.2, B.1
Capillary tubes in concrete surface	III	F	5	$d_a / W \leq 0{,}2$	7.2, B.2
Wooden constructions, pipes in sub floor or under sub floor, conductive devices	IV	G	6	$\lambda_{wl} \geq 10\ \lambda$ $S_{WL\ \lambda} \geq 0{,}01$	7.2, Annex C

7.1, second and third paragraphs

Delete the following:

This calculation method is given in Annex A for the following four types of systems:

— type A with pipes embedded in the screed or concrete (see Figure 2 and A.2.2);

— type B with pipes embedded outside the screed (see Figure 2 and A.2.3);

— type C with pipes embedded in the screed (see Figure 2 and A.2.2);

— type D plane section systems (see A.2.4).

Figure 2 shows the types as embedded in the floor, but the methods can also be applied for wall and ceiling systems with a corresponding position of the pipes.

Replace with the following:

This calculation method is given in Annex A for the following five types of system:

— type I: pipes directly included in a thermal diffusion layer (see Figure 2);

— type II: pipes included in thermal insulation layer with additional thermal conduction layer (see Figure 3);

— type III: capillary tubes directly included in a thermal diffusion layer (see Figure 4);

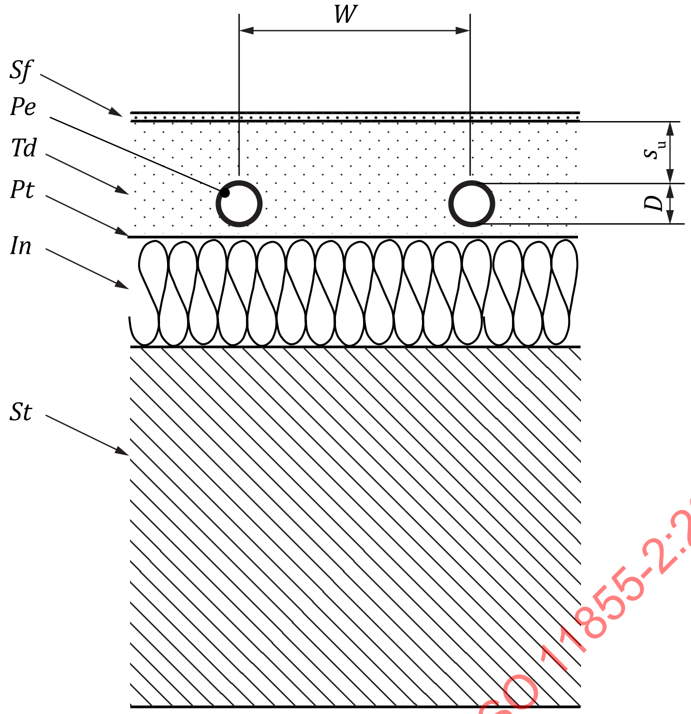
— type IV: pipes with a thermal reflection layer and an air gap to floor covering (see Figure 5);

— type V: pipes included directly in the structural construction (TABS) (see Figure 6).

Figure 3 shows the types as embedded in the floor, but the methods can also be applied for wall and ceiling systems with a corresponding position of the pipes.

7.1, Figure 2 a)

Replace Figure 2 a) with the new Figure 2.



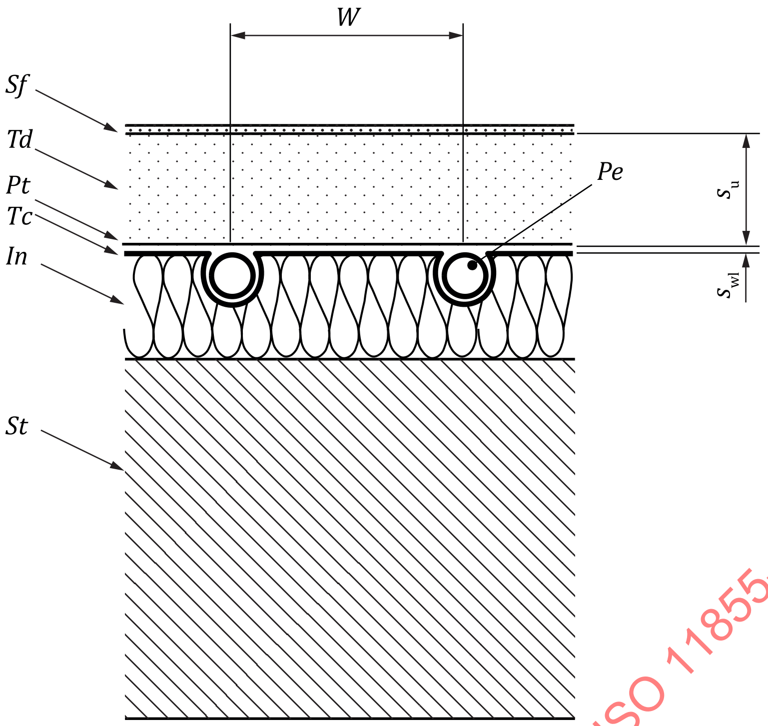
Key

D external diameter of the pipe
In thermal insulation layer
Pe pipes or electric cables
Pt protection layer
Sf surface layer
St structural layer
s_u thickness of the layer above the pipe
Td thermal diffusion layer
W pipe spacing

Figure 2 — Radiant system type I: pipes directly included in a thermal diffusion layer

7.1, Figure 2 b)

Replace Figure 2 b) with the new Figure 3.



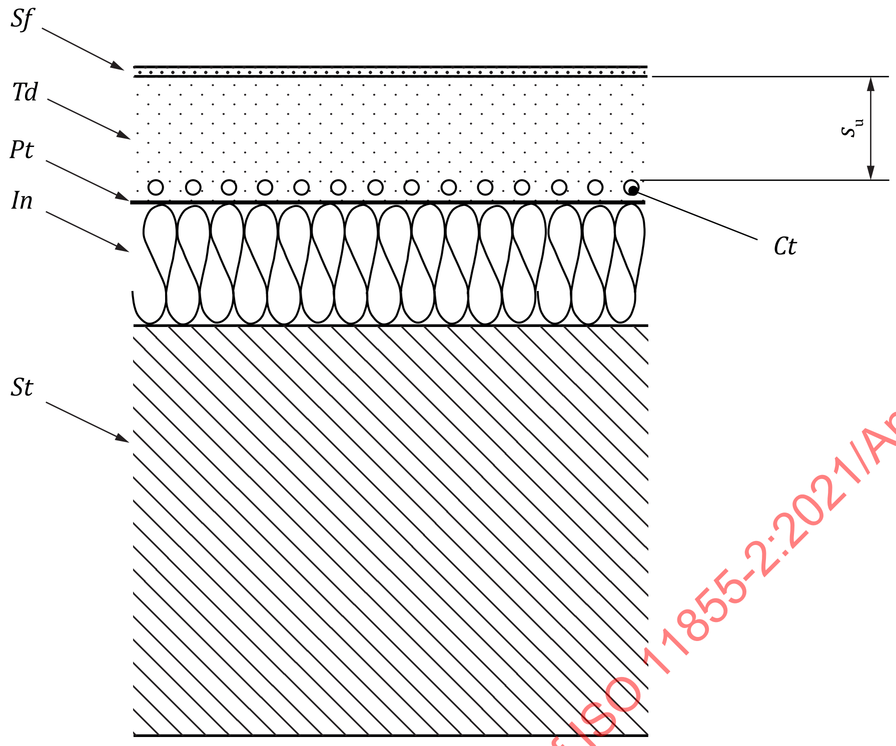
Key

In thermal insulation layer
Pe pipes or electric cables
Pt protection layer
Sf surface layer
St structural layer
s_u thickness of the layer above the pipe
s_{wl} thickness of heat conducting device
Tc thermal conduction layer
Td thermal diffusion layer
W pipe spacing

Figure 3 — Radiant system type II: pipes included in a thermal insulation layer with additional thermal conduction layer

7.1, Figure 2 c)

Replace Figure 2 c) with the new Figure 4.



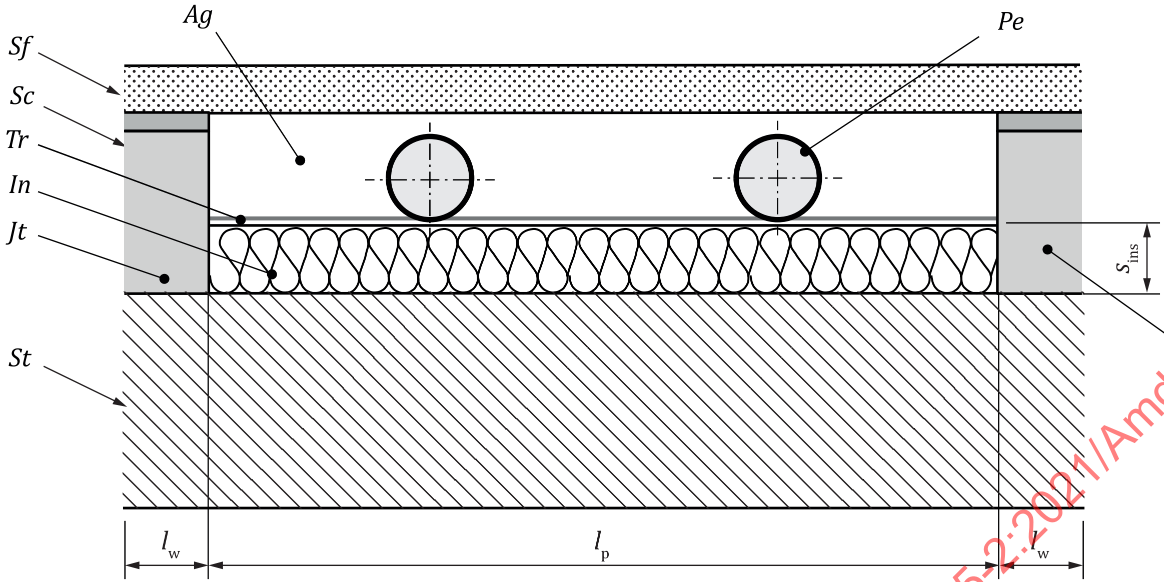
Key

Ct capillary tubes
In thermal insulation layer
Pt protection layer
Sf surface layer
St structural layer
s_u thickness of the layer above the pipe
Td thermal diffusion layer

Figure 4 — Radiant system type III: capillary tubes directly included in a thermal diffusion layer

7.1, Figure 2 d)

Replace Figure 2 d) with the new Figure 5.



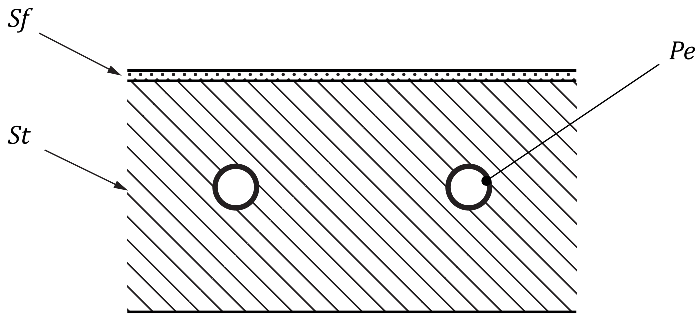
Key

Ag air gap
In thermal insulation layer
Jt joist
l_p distance between the joists
l_w thickness of the joist
Pe pipes or electric cables
Sc structural construction
Sf surface layer (floor covering)
s_{ins} thickness of thermal insulation
St structural layer
Tr thermal reflection layer

Figure 5 — Radiant system type IV: pipes with a thermal reflection layer and an air gap to floor covering

7.1, Figure 2 e)

Replace Figure 2 e) with the new Figure 6.



Key

Pe pipes or electric cables

Sf surface layer

St structural layer

Figure 6 — Radiant system type V: pipes included directly in the structure construction (TABS)

7.1, Figure 2 f)

Remove Figure 2 f).

7.2

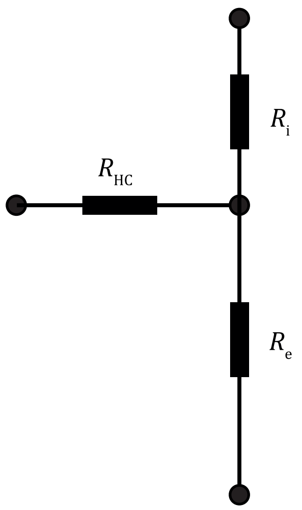
Modify to the following:

The concept is shown in Figure 7.

This calculation method, using the general resistance concept, is given in Annex B for the following two types of system:

— system type V with pipes embedded in massive concrete slabs (see Figure 6);

— system type III with capillary pipes embedded in a layer at the inside surface (see Figure 4).



Key

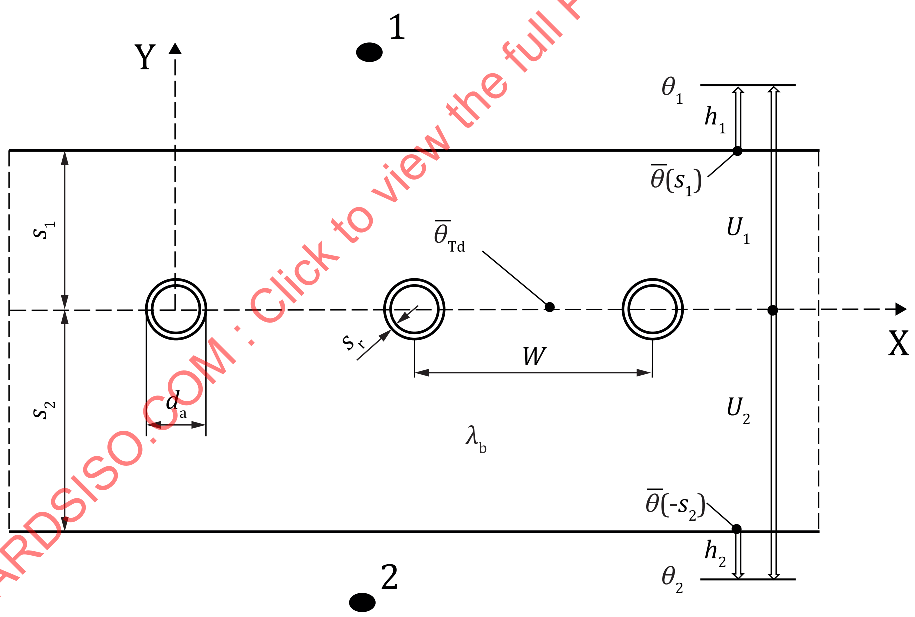
R_e external resistance

R_{HC} equivalent resistance

R_i internal resistance

Figure 7 — Basic network of thermal resistance

Dimensions and other relevant parameters for these constructions are given in Figures 8 and 9.



Key

θ temperature

θ_{Td} temperature of the thermal diffusion layer

λ thermal conductivity

d_a external diameter of the pipe

s thickness

s_r thickness of the pipe wall

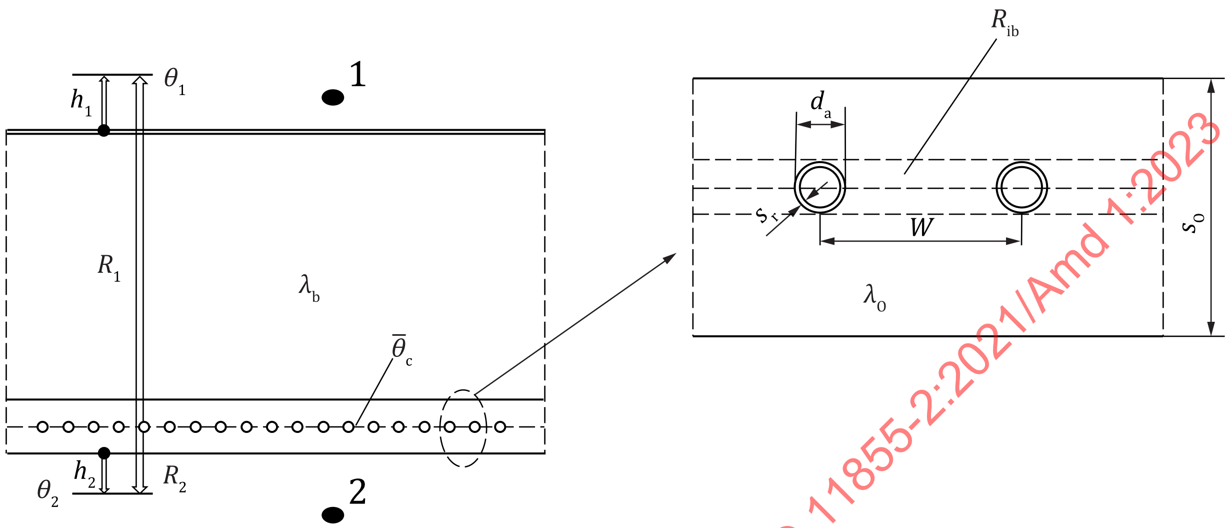
U heat transfer coefficient

W pipe spacing

1 space 1

2 space 2

Figure 8 — Pipes embedded in a massive concrete layer, type V



Key

θ temperature

$\bar{\theta}_c$ temperature of the heat pipes

θ_{Td} temperature of the thermal diffusion layer

λ thermal conductivity

d_a external diameter of the pipe

h distance between the surface and the undisturbed room temperature

R heat resistance of the wall

R_{ib} resistance between the pipes

s thickness

s_r thickness of the pipe wall

U heat transfer coefficient

W pipe spacing

1 space 1

2 space 2

Figure 9 — Capillary pipes embedded in a layer at the inner surface, type III

A.2.1, Table A.1

Modify to the following:

Table A.1 — Criteria for selection of the simplified calculation method

System type	Figure	Boundary conditions	Reference to method
I	Figure 2	$T \geq 0{,}050$ m $s_u \geq 0{,}01$ m $0{,}008 \text{ m} \leq D \leq 0{,}03$ m $s_u/\lambda_e \geq 0{,}01$	A.2.2
II	Figure 3	$0{,}05 \text{ m} \leq T \leq 0{,}45$ m $0{,}014 \text{ m} \leq D \leq 0{,}022$ m $0{,}01 \text{ m} \leq s_u/\lambda_e \leq 0{,}18$ m	A.2.3

A.2.2, first paragraph

Modify to the following:

A.2.2 Systems with pipes inside the screed (system type I)

For these systems (see Figure 2), the characteristic curves are calculated by:

$$q = B \cdot a_B \cdot a_W^{m_W} \cdot a_U^{m_U} \cdot a_D^{m_D} \cdot \Delta\theta_H \tag{A.3}$$

where $B = B_0 = 6{,}7$ in W/m²·K.

A.2.3, first paragraph

Modify to the following:

A.2.3 Systems with pipes below the screed or timber floor (system type II)

For these systems (see Figure 3), the variable thickness s_u of the weight bearing layer and its variable thermal conductivity λ_{WL} are represented by a factor a_U. The pipe diameter has no effect. However, the contact between the heating pipe and the heat conducting device or any other heat distribution device is an important parameter. The characteristic curve is calculated from Formula (A.11):

A.2.4, first paragraph

Modify to the following:

Formula (A.17) applies to surfaces fully covered with embedded heating or cooling elements (see Figure 4):

A.2.5

Replace with the following:

The procedure for the determination of the limits of the heat flux is shown in principle within Figure A.2.

The limit curve (see Figure A.2) gives the relationship between the specific thermal output and the temperature difference between the heating medium and the room for cases where the maximum permissible difference between surface temperature and indoor room temperature (9 K or 15 K, respectively; see Table A.21) is achieved.

The limit curve is calculated using the following expression in form of a product.

The limit curves are calculated by Formula (A.19):

$$q_G = \phi \cdot B_G \cdot \left[\frac{\Delta\theta_H}{\phi} \right]^{n_G} \text{ in W/m}^2 \tag{A.19}$$

where B_G is a coefficient in accordance with:

— for system type I systems: Tables A.5, A.6, A.7 or A.8, depending on the ratio s_u / λ_E;

— for system type II systems: Table A.18;

— for plane section systems: B_G = 100 W/(m²·K);

n_G is an exponent in accordance with:

— for system type I systems: Table A.9 or A.10, depending on the ratio s_u / λ_E;

— for system type II systems: Table A.19;

— for plane section systems: $n_G = 0$.

φ is the factor for conversion to any values of temperatures $\theta_{F,max}$ and θ_i and is calculated according to Formula (A.20):

$$\phi = \left[\frac{\theta_{F,max} - \theta_i}{\Delta\theta_o} \right]^{1,1} \tag{A.20}$$

where $\Delta\theta_o = 9\text{K}$.

The intersection of the characteristic curve with the limit curve is calculated using Formula (A.21), expressed in K:

$$\Delta\theta_{H,G} = \phi \cdot \left[\frac{B_G}{B \cdot \prod_i a_i^{m_i}} \right]^{\frac{1}{1-n_G}} \tag{A.21}$$

The limit curves for system type I systems, for T > 0,375 m, are calculated according to Formulae (A.22) to (A.24):

$$q_G = q_{G;0,375} \frac{0,375\ m}{W} \cdot f_G \tag{A.22}$$

$$\Delta\theta_{H,G} = \Delta\theta_{H,G;0,375} \cdot f_G \tag{A.23}$$

where

$q_{G;0,375}$	is the limit heat flux in W/m², calculated for a spacing W = 0,375 m;
$\theta_{H,G;0,375}$	is the limit temperature difference between the heating medium and the room in K, calculated for a spacing W = 0,375 m.

and

$$f_G = 1,0 \text{ for } \frac{s_u}{W} \le 0,173$$

$$f_G = \frac{q_{G,max} - \left[q_{G,max} - q_{G,0,375} \cdot \frac{0,375}{W} \right] \cdot e^{-20 \cdot (s_u / W - 0,173)^2}}{q_{G,0,375} \cdot \frac{0,375}{W}} \quad \text{for } \frac{s_u}{W} > 0,173 \qquad \text{(A.24)}$$

where $q_{G,max}$ is the maximum permissible heat flux in accordance with Table A.21, calculated for an isothermal surface temperature distribution using the basic characteristic curve (Figure 2), with $(\theta_{F,m} - \theta_i) = (\theta_{F,max} - \theta_i)$.

For system type II systems, Formulae (A.11) and (A.12) apply directly, when the pipe spacing W and the width of the heat diffusion device L_{WL} are the same. For $L_{WL} < W$, the heat flux $q_{G, L_{WL} = W}$, calculated in accordance with Formula (A.11), shall be corrected using Formula (A.25):

$$q_G = \frac{a_{WL}}{a_{WL, L_{WL} = W}} \cdot q_{G, L_{WL} = W} \text{ in W/m}^2 \qquad \text{(A.25)}$$

where

$a_{WL, L_{WL} = W}$	is the heat conduction factor in accordance with Tables A.11 to A.16, in W/(m²·K);
a_{WL}	is the heat conduction factor, calculated in accordance with Formula (A.16), in W/(m²·K).

The limit temperature difference between the heating medium and the room, $\Delta\theta_{H,G}$, remains unchanged as with $L_{WT} = W$.

For $\Delta\theta_H = \theta_{F,max} - \theta_i = 9\text{K}$, $\varphi = 1$ and $R_{\lambda,B} = 0$, the limit heat flux q_G is designated as the heat flux, q_N, and the associated heating medium differential temperature $\Delta\theta_H$ is designated as the nominal heating medium differential temperature, $\Delta\theta_N$.

The maximum possible value of the heat flux, $q_{G,max}$, for isothermal surface temperature distribution lies on the basic characteristic curve (see Clause 6, Figure 1, where $\theta_{F,m} = \theta_{F,max} = \theta_{S,max}$).

If values of q_G higher than $q_{G,max}$ are determined by Formula (A.19) due to inaccuracy of calculations, interpolations and linearization, $q_G = q_{G,max}$ shall be applied.

A.2.7

Replace with the following:

For type I systems, the thermal conductivity in the screed is changed by inserts such as attachment studs or similar components. If their λ_E volume percentage in the screed amounts to $15\ \% \geq \psi \geq 5\ \%$, an effective thermal conductivity of the component, λ'_E, shall be used for calculations [see Formula (A.28), expressed in W/(m·K)]:

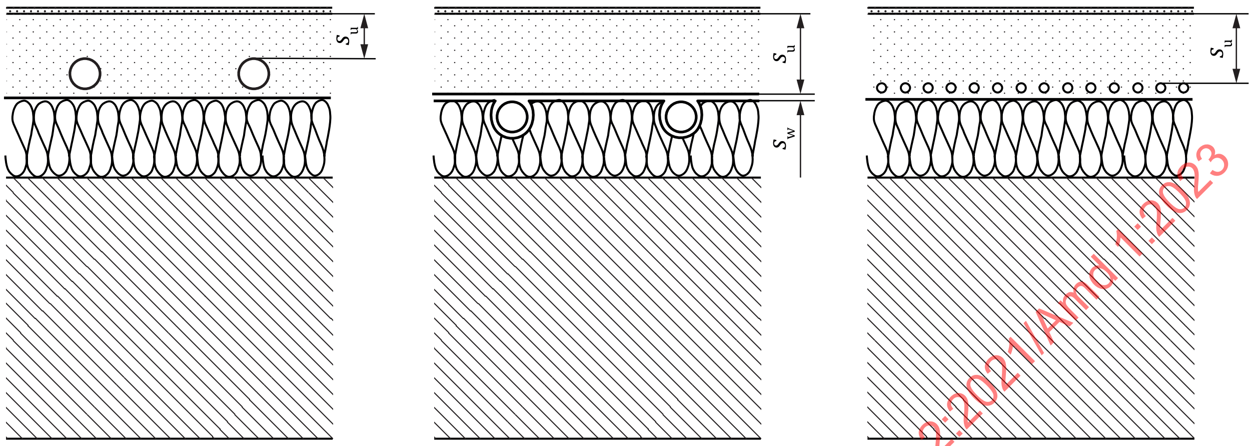
$$\lambda'_E = (1 - \psi) \cdot \lambda_E + \psi \cdot \lambda_W \qquad \text{(A.28)}$$

where

λ_E	is the thermal conductivity of the screed in W/(m·K);
λ_W	is the thermal conductivity of the attachment studs in W/(m·K);
Ψ	is the volume ratio of the attachment studs in the screed.

A.4, Figure A.1, Figure A.2 and Figure A.3

Delete Figure A.1, Figure A.2 and Figure A.3 and insert new Figure A.1 as follows:



a) Type I **b) Type II** **c) Type III**

Key

s_u thickness of the layer above the pipe

s_w thickness of the heat conducting device

Figure A.1 — Definition of s_u for the different system types

Figure A.4

Change figure number from Figure A.4 to Figure A.2.

Figure A.5

Change figure number from Figure A.5 to Figure A.3.

Figure A.6

Change figure number from Figure A.6 to Figure A.4.

Table A.2

Modify table title as follows:

Table A.2 Pipe spacing factor for a_W for system type I

Table A.3

Modify table title as follows:

Table A.3 — Covering factor a_U depending on pipe spacing T and thermal conduction resistance of the surface covering for system type I

Table A.4

Modify table title as follows:

Table A.4 — Pipe external diameter factor a_D depending on thermal conduction resistance $R_{\lambda,B}$ of the floor covering and the pipe spacing W for system type I

Table A.5

Modify table title as follows:

Table A.5 — Coefficient B_G, depending on the ratio s_u/λ_E for $s_u/\lambda_E \leq 0{,}079\,2$ and on the pipe spacing T for systems with pipes installed inside the screed (system type I)

Table A.6

Modify table title as follows:

Table A.6 — Coefficient B_G, depending on the ratio s_u/W for $s_u/\lambda_E > 0{,}079\,2$ for systems with pipes installed inside the screed (system type I)

Table A.7

Modify table title as follows:

Table A.7 — Exponent n_G, depending on the ratio s_u/λ_E for $s_u/\lambda_E \leq 0{,}079\,2$ and on the pipe spacing W for systems with pipes installed inside the screed (system type I)

Table A.8

Modify table title as follows:

Table A.8 — Exponent n_G, depending on the ratio s_u/W for $s_u/\lambda_E > 0{,}079\,2$ for systems with pipes installed inside the screed (system type I)

Table A.9

Modify table title as follows:

Table A.9 — Pipe spacing factor a_W for system type II

Table A.10

Modify table title as follows:

Table A.10 — Factor b_u depending on pipe spacing W for system type II

Table A.11

Modify table title as follows:

Table A.11 — Heat conduction device factor a_{WL} depending on pipe spacing W, pipe external diameter D and characteristic value K_{WL} for system type II (K_{WL} = 0)

Table A.12

Modify table title as follows:

Table A.12 — Heat conduction device factor a_{WL} depending on pipe spacing W, pipe external diameter D and characteristic value K_{WL} for system type II (K_{WL} = 0,1)

Table A.13

Modify table title as follows:

Table A.13 — Heat conduction device factor a_{WL} depending on pipe spacing W, pipe external diameter D and characteristic value K_{WL} for system type II (K_{WL} = 0,2)

Table A.14

Modify table title as follows:

Table A.14 — Heat conduction device factor a_{WL} depending on pipe spacing W, pipe external diameter D and characteristic value K_{WL} for system type II (K_{WL} = 0,3)

Table A.15

Modify table title as follows:

Table A.15 — Heat conduction device factor a_{WL} depending on pipe spacing W, pipe external diameter D and characteristic value K_{WL} for system type II (K_{WL} = 0,4)

Table A.16

Modify table title as follows:

Table A.16 — Heat conduction device factor a_{WL} depending on pipe spacing W and characteristic value K_{WL} for system type II ($K_{WL} \geq 0,5$) (a_{WL} no longer dependent on D)

Table A.17

Modify table title as follows:

Table A.17 — Correction factor for the contact a_K for system type II

Table A.18

Modify table title as follows:

Table A.18 — Coefficient B_G depending on K_{WL} and pipe spacing W for system type II