BS EN 14037-5:2016

BSI Standards Publication

Free hanging heating and cooling surfaces for water with a temperature below 120°C

Part 5: Open or closed heated ceiling surfaces — Test method for thermal output

bsi.

National foreword

This British Standard is the UK implementation of EN 14037-5:2016.

The UK participation in its preparation was entrusted to Technical Committee RHE/6, Air or space heaters or coolers without combustion.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2016

ISBN 978 0 580 90461 5

ICS 91.140.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 September 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14037-5

September 2016

ICS 91.140.10

English Version

Free hanging heating and cooling surfaces for water with a temperature below 120°C - Part 5: Open or closed heated ceiling surfaces - Test method for thermal output

Panneaux rayonnants de chauffage et de rafraîchissement alimentés avec une eau à une température inférieure à 120 °C - Partie 5 : Méthode d'essai pour la détermination de la puissance thermique des surfaces de plafond de chauffage ouverts ou fermés

An der Decke frei abgehängte Heiz- und Kühlflächen für Wasser mit einer Temperatur unter 120 °C - Teil 5: Prüfverfahren für die Wärmeleistung von offenen oder geschlossenen Deckenheizflächen

This European Standard was approved by CEN on 18 March 2016.

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 14037-5:2016 E

Contents

Page

European foreword

This document (EN 14037-5:2016) has been prepared by Technical Committee CEN/TC 130 “Space heating appliances without integral heat sources”, the secretariat of which is held by UNI.

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 March 2017, and conflicting national standards shall be withdrawn at the latest by March 2017.

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.

The European Standard EN 14037, *Free hanging heating and cooling surfaces for water with a temperature below 120°C*, consists of the following parts:

— *Part 1: Pre-fabricated ceiling mounted radiant panels for space heating - Technical specifications and requirements*

— *Part 2: Pre-fabricated ceiling mounted radiant panels for space heating - Test method for thermal output*

— *Part 3: Pre-fabricated ceiling mounted radiant panels for space heating - Rating method and evaluation of radiant thermal output*

— *Part 4: Pre-fabricated ceiling mounted radiant panels for space heating - Test method for cooling capacity*

— *Part 5: Open or closed heated ceiling surfaces - Test method for thermal output*

According to the CEN/CENELEC Internal Regulations, the national standards organisations 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.

Introduction

This European Standard results from the recognition, that heated and chilled ceiling radiant panels falling into the field of application hereinafter stated are traded on the basis of their thermal output. For evaluating and comparing different heated and chilled ceiling surfaces it is therefore necessary to refer to a heating stipulated value.

As installations with ceiling mounted radiant panels can also be used in practice for space cooling, it is necessary to have a test method for evaluating the cooling capacity. Installations with different free hanging heating and cooling surfaces need, for the use of space heating a test method for evaluating the heating output. The test method differs from the method for ceiling mounted radiant panels.

1 Scope

This European Standard describes the test method and the test installation for determining the thermal output of ceiling mounted heating surfaces according to the specifications 3.1, 3.2. and 3.3.

This part applies to determine thermal output when chilled ceilings according to EN 14240 are also used for heating.

NOTE Test results according to this part cannot be compared with results according EN 14037–2 because great discrepancies are given at open ceilings, convective components and heating surfaces without upper insulation.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 14037-1:2016, *Pre-fabricated ceiling mounted radiant panels for space heating - Technical specifications and requirements*

EN 14037-2:2016, *Pre-fabricated ceiling mounted radiant panels for space heating - Test method for thermal output*

EN ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14037-1:2016 and the following apply.

3.1
open or closed ceiling surface
open or closed active and non-active elements of chilled ceilings, which are additionally used for heating, which are part of suspended ceilings and generally constructed modular from industrially prefabricated elements

3.2
free hanging sail
surface composed of one or more elements of a cooling installation which is additionally used for heating

Note 1 to entry: Depending on the use of the sails they can be covered with thermal insulation or noise absorption material.

3.3
suspended ceiling with integrated heating elements
single closed elements which are used for heating and are thermally insulated on the upper side, integrated in closed hanging ceilings and combined with non-active elements

3.4
mean radiant temperature
temperature in a defined point of the room resulting from the radiation of all surrounding surfaces and of the heated ceiling surface

3.5
standard temperature difference of heated ceiling surfaces
mean water temperature 35°C and reference room temperature 20°C, determined temperature difference 15 K

3.6
active heated ceiling surface
relating to thermal output of heated ceiling surfaces

3.7
module
1 m^2 active surface of a heated ceiling surface

4 Symbols and units

For the purposes of this document, the symbols and units given in EN 14037-1:2016 and the following apply.

Table 1 — Symbols and units

No.	Quantity	Symbol	Unit
1	Installation surface	A_i	m^2
2	Active surface	A_a	m^2
3	Total active surface	A_{atot}	m^2
4	Constant of the characteristic equation of the active surface	K_{act}	W/K^{nact}
5	Constant of the characteristic equation of the module	K_{actM}	$W/(m^2\ K^{nact})$
6	Constant of the characteristic equation of the installation surface	K_{tot}	W/K^{ntot}
7	Exponent of the characteristic equation of the active surface	n_{act}	-
8	Exponent of the characteristic equation of the installation surface	n_{tot}	-
9	Active area ratio	R_a	-
10	Modular thermal output	Φ_L	W/m^2
11	Standard modular thermal output [a]	Φ_{Ls}	W/m^2
12	Standard temperature difference of a heated cooling surface when heating (15 K) [a]	ΔT_s	K
a "s" indicates that the value is in standard conditions.			

5 Testing of thermal output

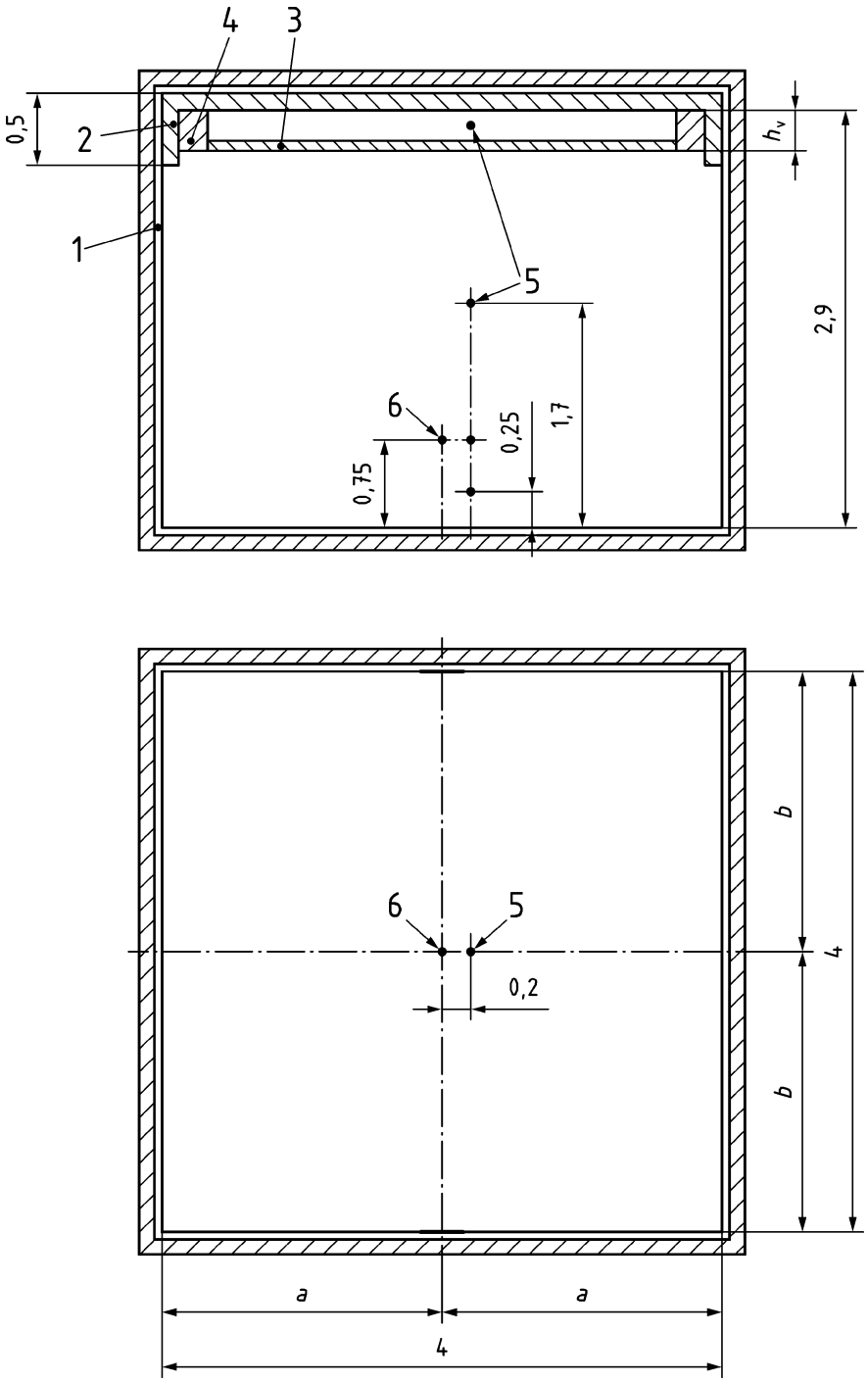
The test is carried out in a testing system, which consists of a closed booth with controlled temperatures of the inside surfaces plus a set of two master panels built according to EN 14037-2:2016, Clause 6.

Differing from the definitions of the test booth according to EN 14037-2:2016, the ceiling and the upper part of the vertical walls of the test booth shall be insulated until 0,5 m (±0,02 m) below the ceiling with a specific thermal resistance of > 2,5 (m K)/W.

The method for measuring the thermal output consists of the measurement of mass flow and enthalpy difference between inlet and outlet (by weighing method). Other measurement methods shall guarantee in minimum the precision obtained by weighing method. The natural convection within the test booth shall not be affected by additional means.

All laboratories that make tests according to this standard have to make comparable measurements with the other laboratories (according to EN 14037-2:2016, Clause 6).

Dimension in meter



Key

1 test booth
2 insulation
3 test specimen
4 edge insulation plate
5 measuring point of air temperature
6 measuring point of Globe temperature
h_v distance from the lower surface to the test item to the insulated ceiling of the test booth

Figure 1 — Example of a test booth with arrangement of a closed heated ceiling and the temperature measuring points

6 Test methods

The test method shall be carried out according to EN 14037-2:2016, Clause 7.

7 Carrying out the measurement

7.1 General

The natural convection inside the test booth shall not be influenced by additional means.

7.2 Test design

The test sample shall be installed in the test booth according to the instructions of the manufacturer. The arrangement of the sample shall be symmetrical if possible otherwise as much regular as possible. In case of closed ceilings (see 3.1 and 3.3) filling parts have to be installed when the projected surface is smaller than the test booth. The filling parts shall be thermally insulated according to Clause 5.

The total standard heat output of the installed sample shall be minimum 400 W and the active surface shall cover at least 15 % of the total ceiling of the test booth (approx. 2,2 m^2).

The active area ratio shall be calculated with:

$$R_a = \frac{A_a}{A_i} \quad (1)$$

where

R_a the active area ratio;

A_a the active surface, it consists of the sum of the connected surface elements, that are projected on the floor and connected to the heating system, overlapping surfaces will be single evaluated.

A_i the installation surface.

At closed ceiling surfaces the active area ratio shall be declared together with the standard output value.

The distance from the lower surface of the test item to the insulated ceiling of the test booth h_v (void behind the item including the height of the test item) shall not exceed 300 mm.

7.3 Connection of the test sample to the measuring circuit

After installation and connection to the measuring circuit, the test sample and the water circuit shall be carefully vented. During the test, the measuring circuit shall be free of air inclusions.

The procedure of venting is to be described in the working instructions of the test laboratory.

If the connecting pipes are not an element of the standard installation, but are intended for the test, they shall be provided with a maximum thermal conductivity of 4 $W/(m^2 \cdot K)$.

7.4 Mass flow

The water flow rate shall be regulated so that the result of the difference between inlet and outlet temperature shall be 4 K ± 0,2 K at a temperature difference of 20 K ± 2 K. During the test for measuring the three points of the characteristic equation, the mass flow rate shall be constant at each measuring point and shall not differ more than 5 % from one point to another.

7.5 Test temperature

To determine the characteristic equation measurements are carried out at three different mean temperatures of the ceiling heating surface. These mean temperatures shall be calculated from the respective inlet and outlet temperatures. They shall be within the following ranges:

— 28 °C to 32 °C;

— 38 °C to 42 °C;

— 48 °C to 52 °C.

7.6 Reference room temperature

Before the measurement the reference room temperature of 20 °C (±0,5) °C has to be held in steady-state conditions for 30 min.

7.7 Steady-state conditions

Steady-state conditions shall be maintained throughout the duration of the test, as far as both, the primary fluid circuit and the ambient conditions in the test installation are concerned. Parameters are to be monitored at regular intervals. Steady-state conditions are deemed to exist when the standard deviations of all readings (not less than 12 sets in minimum 6 min) amount to less than half of the ranges specified below:

— water and air temperature ± 0,1 K;

— water flow rate 1,0 %.

7.8 Heat output

The measured heat output is calculated by:

$$\Phi_{\mathrm{me}} = q_{\mathrm{m}} \left(h_2 - h_1 \right) \tag{2}$$

To take in account air pressures deviating from p_s = 101,325 kPa, the measured output Φ_{me} shall be corrected as follows:

$$\Phi = \Phi_{\mathrm{me}} \left(0,65 + 0,35 \left(\frac{p_{\mathrm{s}}}{p} \right)^{0,4} \right) \tag{3}$$

7.9 Result of measurement – characteristic equation

Having been corrected according to 7.8 the values of the thermal output are plotted over the measured values of excess temperature and the characteristic equation as well as its mathematical function is determined. The equation for the characteristic of a model reads as follows:

— Characteristic equation of the test sample $\Phi_{\mathrm{tot}} = K_{\mathrm{tot}} \cdot \Delta T^{n\mathrm{tot}}$ (4)

— Characteristic equation of the active surface $\Phi_{\mathrm{L}} = K_{\mathrm{act}} \cdot \Delta T^{n\mathrm{act}}$ (5)

The constant K and the exponent n are determined by regression according to EN 14037-2:2016, Annex C. The standard output is calculated from the function of the characteristic equation.

7.10 Standard output

The standard output is the thermal output related to the active surface with an temperature difference of 15 K. The standard output is calculated from the function of the characteristic equation.

7.11 Interpolation of values of the thermal output

An interpolation of the values of standard thermal output according to a characteristic geometrical size can be carried out, The interpolation of the thermal output and exponent is allowed, if the ratio of characteristic geometrical size does not exceed 2. Interpolation shall be linear. An extrapolation is not allowed.

For example a characteristic geometrical size could be the surface coverage or a distance.

8 Upper insulation

To keep the high energy efficiency for radiant heating surfaces it is recommended to insulate these surfaces at the upper side and to design the elements for low convection. It should be considered that surfaces with reduced or without upper insulation which are mainly used for cooling will result in a much lower efficiency in the heating.

9 Test report

9.1 General

Person/organization performing the test shall prepare a test report based on the procedures and calculation contained in this European Standard. The test report shall be in accordance with EN ISO/IEC 17025:2005, 5.10.2 and 5.10.3.

NOTE Within the framework of CPR, System 3, this task would be performed by a laboratory.

The laboratory is only allowed to prepare a test report with reference to this standard, if the test sample fulfils the construction requirements of 3.2, 3.3 and 3.4.

9.2 Data

The following data shall be at least stated in the test report:

a) name and address of the test institute;

b) location of test (if different from the test institute);

c) name and address of the customer;

d) identification of test method used;

e) description of the test booth;

f) identification of the test samples including, trade mark, model number, dimensions;

g) dates of testing;

h) the active area ratio;

i) information about upper insulation;

j) a detailed engineering construction drawing of the test sample and its used materials;

k) test results:

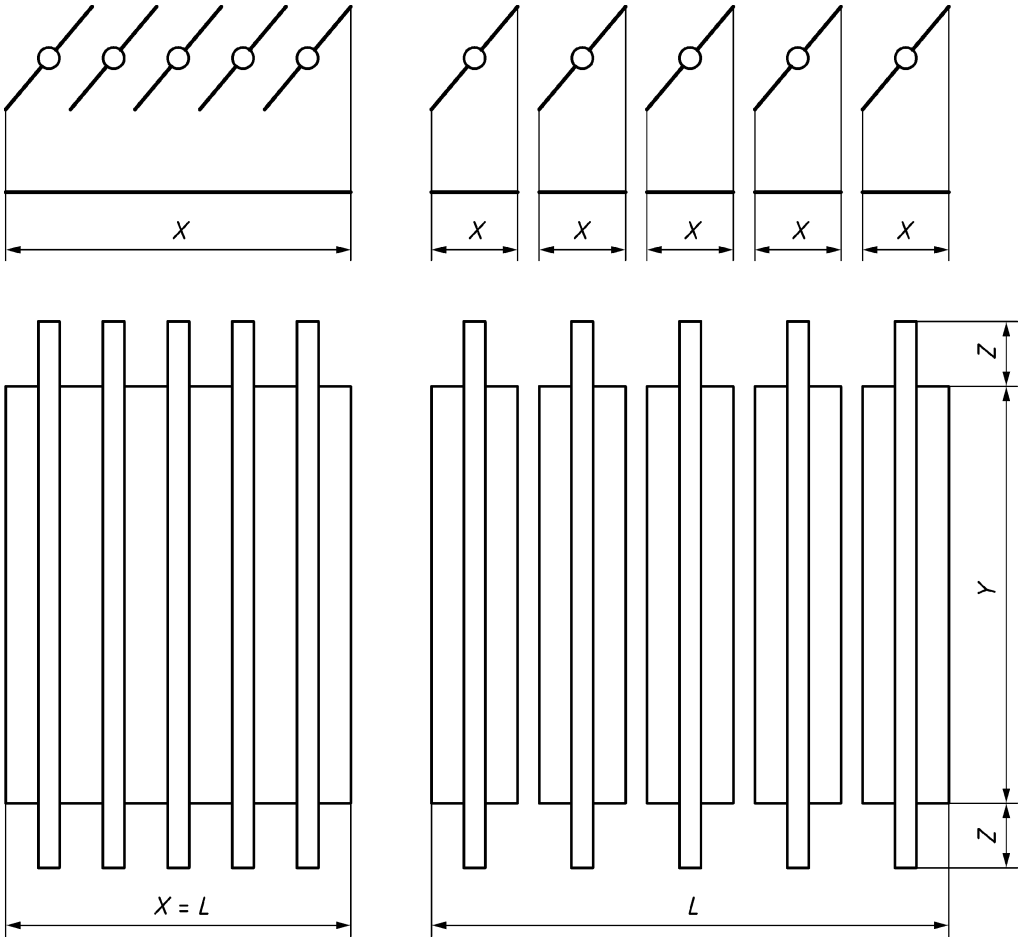
1) test data (see Annex A) including e.g. water temperatures, air temperatures, globe temperature, water flow rate;

2) the characteristic equation of the tested model;

3) the standard thermal output of the tested model and the characteristic equation related to the active surface.

The constant *K* and the exponent *n* should be represented with 3 decimal places, the standard output with one decimal place. Performance appointing temperatures (water, globe) have to be stated with 2 decimal places and all other temperatures with 1 decimal place.

10 Examples for the determination of the active length of different ceiling mounted heating surfaces



a) Modules with overlapping single elements

A_i = L x (Y +2 Z)

A_a = L x Y

Active surface = A_a

b) Modules without overlapping single elements

A_i = L x (Y +2 Z)

A_a = ΣX x Y

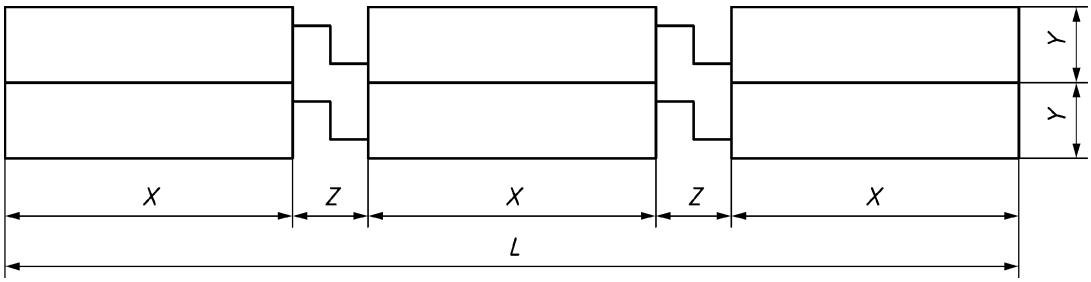
Key

X projected length of active surfaces

Y width of the active part

Z width of the edge trim (covering of connection and/or interconnection)

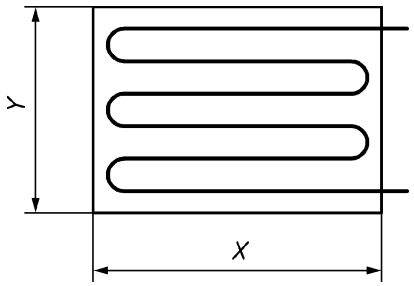
Figure 2 — Example for modules



$A_a = 6 \times X \times Y$

$A_i = L \times 2Y = (3X + 2Z) \times 2Y$

Figure 3 — Example for modules connected in series



Active surface of single module: $A_a = X \times Y$

or in case of activated ceilings (without modules, e.g. plasterboard) the active surface is the installation surface $A_a = A_i = L \times B$ (see Figure 6).

Figure 4 — Example for closed ceiling mounted heating surfaces

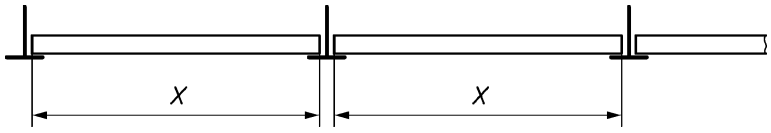
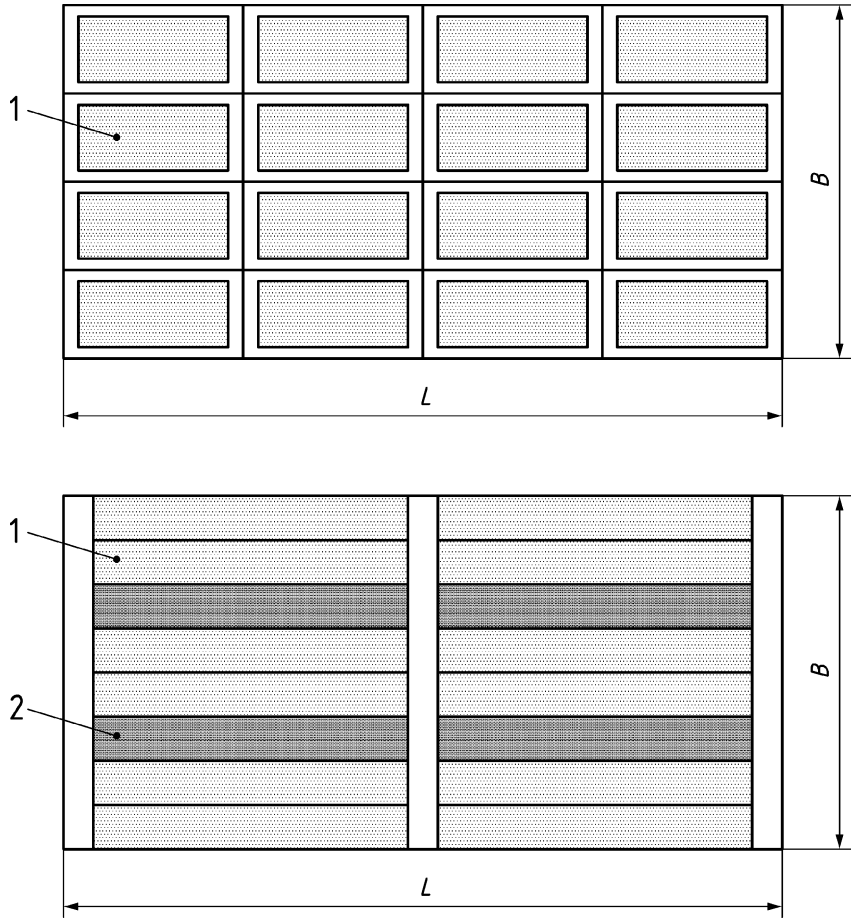


Figure 5 — Section of a ceiling mounted heating surface with single modules in a ceiling grid



Key

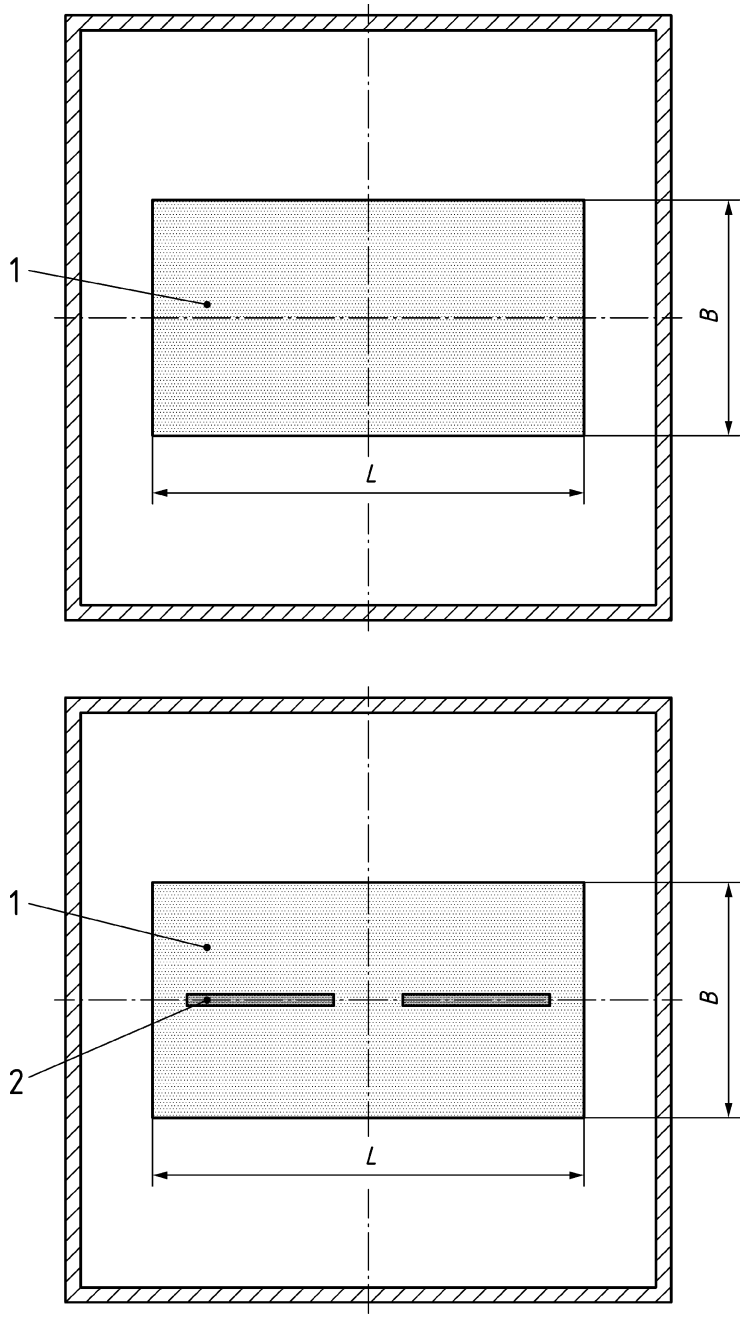
1 active panel

2 panel without heating elements or inactive panel

The installation surface A_i = L x B results from the size of the ceiling grid.

Active surface of single module: A_a = X x Y

Figure 6 — Ceiling mounted heating surfaces with 16 modules and a total active area A_{atot} = 16 × (X x Y) (upper sketch) A_{atot} = 12 × (X x Y) (lower sketch)

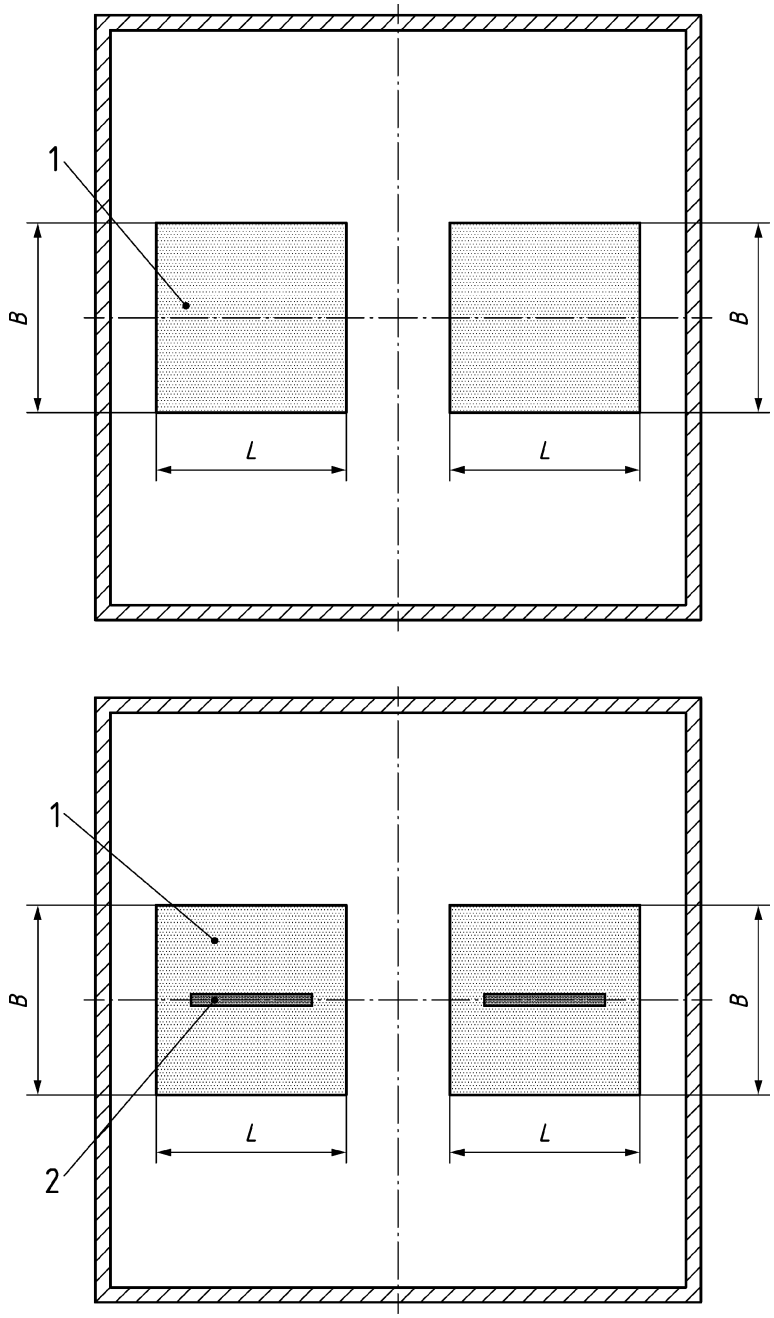


Key

1 active panel

2 inactive areas without heating elements

Figure 7 — Examples for free hanging sails A_i = L x B = A_{atot}



Key

1 active panel

2 inactive areas without heating elements

Figure 8 — Examples for free hanging sails $A_i = 2$ (L x B) = A_{atot}

Annex A
(informative)

Specimen of the test report for heating capacity

The test report shall contain the following information:

---

test report no.: ..... date: .....

institute:.....

A brief description of the test booth is attached: (inside dimensions, water circulating system in the walls, measuring devices for water flow and temperatures)

this report consists of .....pages and it can be reproduced only in its integral form.

customer: .....

customer address:.....

---

test according to EN 14037-1, –2 and –5

data of the test sample: (active surface, installation surface, identification of the model, identification of the manufacturer, materials, dimensions, water circuit design, connecting components, dimensions of connections,
design of surface, bonding between wet and dry surface, suspension, upper insulation, maximum operating pressure, maximum temperature, dry mass, water content)

.....

drawing of the test sample

---

manufacturers trademark (identification): .....

Identification of the test sample: .....

Signature of the	Test Engineer	and the	Laboratory Director
	.....		.....

Results of test

	Symbols	unit	measuring points		
			1	2	3
Date of measurement					
Air pressure	p	kPa			
Reference room temperature	t_{ref}	°C			
Inlet water temperature	t_1	°C			
Outlet water temperature	t_2	°C			
Water temperature drop	t_1- t_2	K			
Inlet water enthalpy	h_1	J/kg			
Outlet water enthalpy	h_2	J/kg			
Enthalpy difference	h_1- h_2	J/kg			
Mean water temperature	t_m	°C			
Temperature difference	ΔT	K			
Water flow rate	q_m	kg/s			
Measured output	Φ_{me}	W			
Output corrected for barometric pressure	Φ	W			
Thermal output related to active surface	Φ_L	W/m²			

Characteristic equation of the tested sample: $\Phi = K_{tot} \times \Delta T^{n_{tot}}$

where

K_{tot} = ...

n_{tot} = ...

Characteristic equation of the tested sample related to the active surface: $\Phi_L = K_{actM} \times \Delta T^{n_{act}}$

where

K_{actM} = ...

n_{act} = ...

Control temperatures

	unit	Measuring points		
		1	2	3
Air temperature 0,25 m above floor	°C			
Air temperature 0,75 m above floor	°C			
Air temperature 1,7 m above floor	°C			
Air temperature in the void	°C			
Surface temperature wall 1	°C			
Surface temperature wall 2	°C			
Surface temperature wall 3	°C			
Surface temperature wall 4	°C			
Surface temperature wall 5 (floor)	°C			
Surface temperature wall 6 (ceiling)	°C			

Bibliography

[1] ISO 5725 (all parts), *Accuracy (trueness and precision) of measurement methods and results*

[2] EN ISO 80000-5, *Quantities and units - Part 5: Thermodynamics (ISO 80000-5)*

[3] EN 14240, *Ventilation for buildings - Chilled ceilings - Testing and rating*

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit, or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than 1 device provided that it is accessible by the sole named user only and that only 1 copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than 1 copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright & Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email subscriptions@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services
Tel: +44 345 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 345 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.