BS EN 14037-2:2016

BSI Standards Publication

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

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

bsi.

**National foreword**

This British Standard is the UK implementation of EN 14037-2:2016. It supersedes BS EN 14037-2:2003 which is withdrawn.

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 90458 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 14037-2**

September 2016

ICS 91.140.10

Supersedes EN 14037-2:2003

English Version

# Free hanging heating and cooling surfaces for water with a temperature below 120°C - Part 2: Pre-fabricated ceiling mounted radiant panels for space heating - Test method for thermal output

Panneaux rayonnants de chauffage et de rafraîchissement alimentés avec une eau à une température inférieure à 120 °C - Partie 2 : Méthode d'essai pour la détermination de la puissance thermique des panneaux rayonnants de plafond préfabriqués destinés au chauffage des locaux

An der Decke frei abgehängte Heiz- und Kühlflächen für Wasser mit einer Temperatur unter 120 °C - Teil 2: Vorgefertigte Deckenstrahlplatten zur Raumheizung - Prüfverfahren für die Wärmeleistung

This European Standard was approved by CEN on 19 March 2016.

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



Ref. No. EN 14037-2:2016 E

# Contents

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# European foreword

This document (EN 14037-2:2016) 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 document supersedes EN 14037-2:2003.

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 main changes are:

— the title has been changed,

— the introduction has been changed,

— the scope has been changed,

— a new Master panel 2 has been added,

— Clause 9 “Test Report” has been reworked.

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 pre-fabricated ceiling mounted radiant panels according to the specifications of EN 14037-1:2016, 3.3.1.

# 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, *Prefabricated ceiling mounted radiant panels for space heating - Technical specifications and requirements*

EN 14037-3:2016, *Prefabricated ceiling mounted radiant panels for space heating - Rating method and evaluation of radiant 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 apply.

# 4 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 Clause 6.

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.

All laboratories that make tests according this standard have to make comparable measurements with the other laboratories (according to Clause 6 of this standard).

# 5 Test booth

## 5.1 General

The booth for testing ceiling mounted radiant panels shall be constructed in a way that all six surrounding surfaces can be chilled.

Figure 1 shows the schematic lay-out of a test booth with a six-wall cooling. The walls are defined as follows:

— Wall 1: the wall parallel to the inlet header;

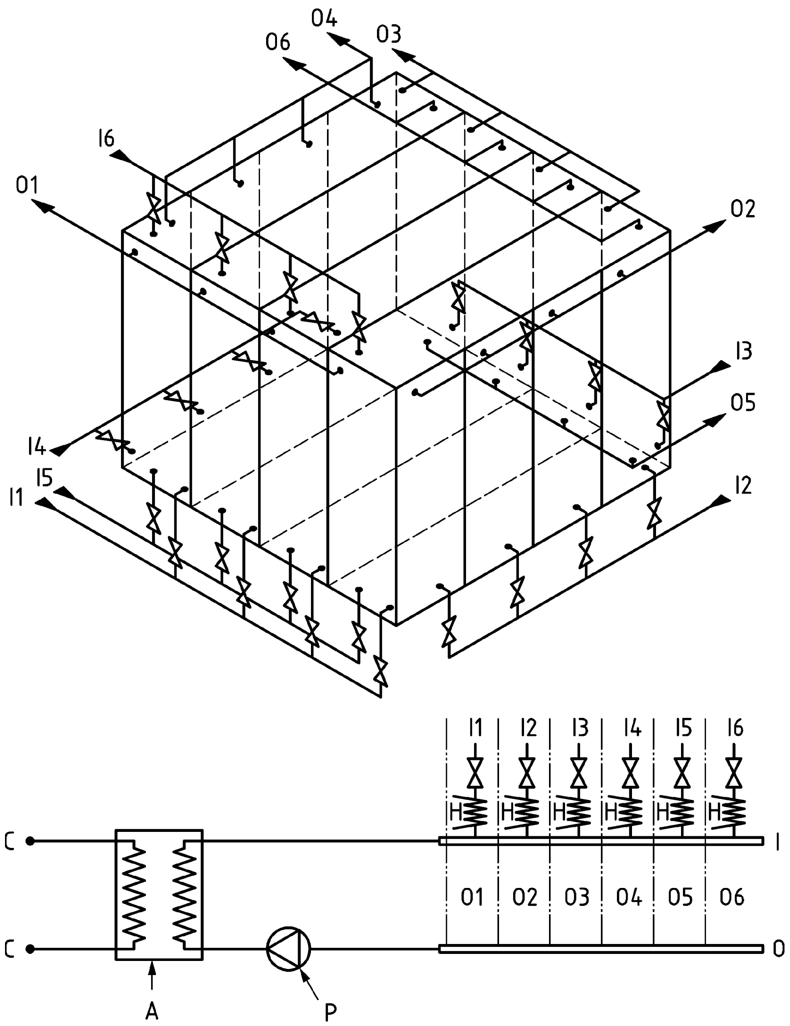
— Wall 2: the wall to the right of wall 1;

— Wall 3: the wall opposite of wall 1;

— Wall 4: the wall to the left of wall 1;

— Wall 5: the floor;

— Wall 6: the ceiling.




**Key**

| | |
|---|---|
| C | cooling circuit connection |
| I | inlet cooling water |
| O | outlet cooling water |
| A | cooling water accumulator |
| P | circulating pump |
| H | after heater |
| 1....6 | designation of the surrounding inside surfaces |

**Figure 1 — Example of the hydraulic system of a test booth**

## 5.2 Dimensions of the test booth

The test booth has to have the following inside dimensions:

— Length: (4 ± 0,02) m;

— Width: (4 ± 0,02) m;

— Height: (3 ± 0,02) m.

## 5.3 Emissivity of the inside surrounding surfaces

Walls, ceiling and floor shall have smooth inside surfaces covered with a coat of mat paint having a degree of emissivity of minimum 0,9.

## 5.4 Tightness of the test booth

The test booth construction shall be sufficiently tight to prevent air infiltration.

## 5.5 Cooling system

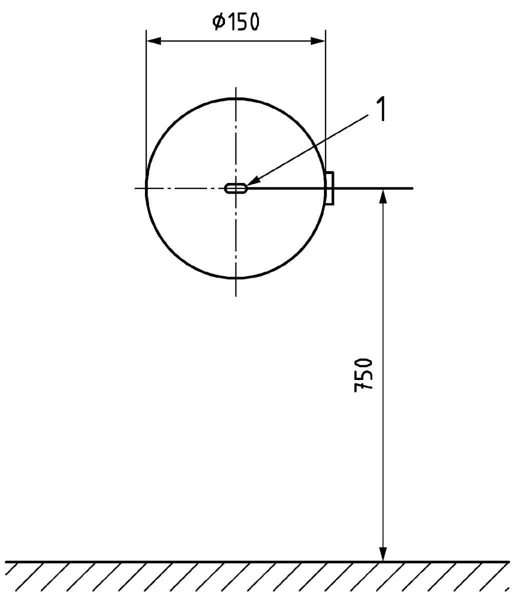
The cooling system is to be carried out in order, that the difference between the 6 chilled surrounding inside surfaces of the test booth and the average temperature of all 6 surfaces is not higher than 0,5 K. The temperature difference between inlet and outlet shall not be higher than 0,5 K. That condition shall be maintained at the tests for the determination of the characteristic equation.

## 5.6 Temperature measuring points

### 5.6.1 Reference room temperature

The reference room temperature is measured at a height of 0,75 m above the floor of the test booth by means of a globe thermometer (see Figure 2). The measuring point is situated on the vertical axis through the central point of the ceiling mounted radiant panel.

Dimensions in millimetres




**Key**

1 temperature measuring point

**Figure 2 — Globe thermometer**

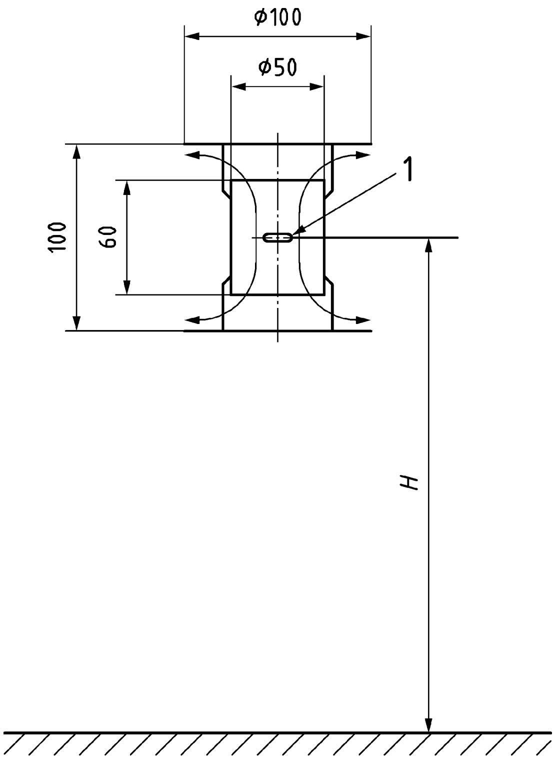
Temperature sensor with blackened light metal sphere (diameter 150 mm, emissivity 0,9). The measuring point is arranged in the centre of the sphere. The penetration of the temperature sensor through the surface of the sphere runs horizontally and is air tight. The hollow sphere is attached to the temperature sensor.

### 5.6.2 Air temperature

The air temperature is measured with sensors protected against radiation (see Figure 3).

The measuring points are situated on 2 vertical axes at 3 different heights as shown in Figure 4.

Dimensions in millimetres



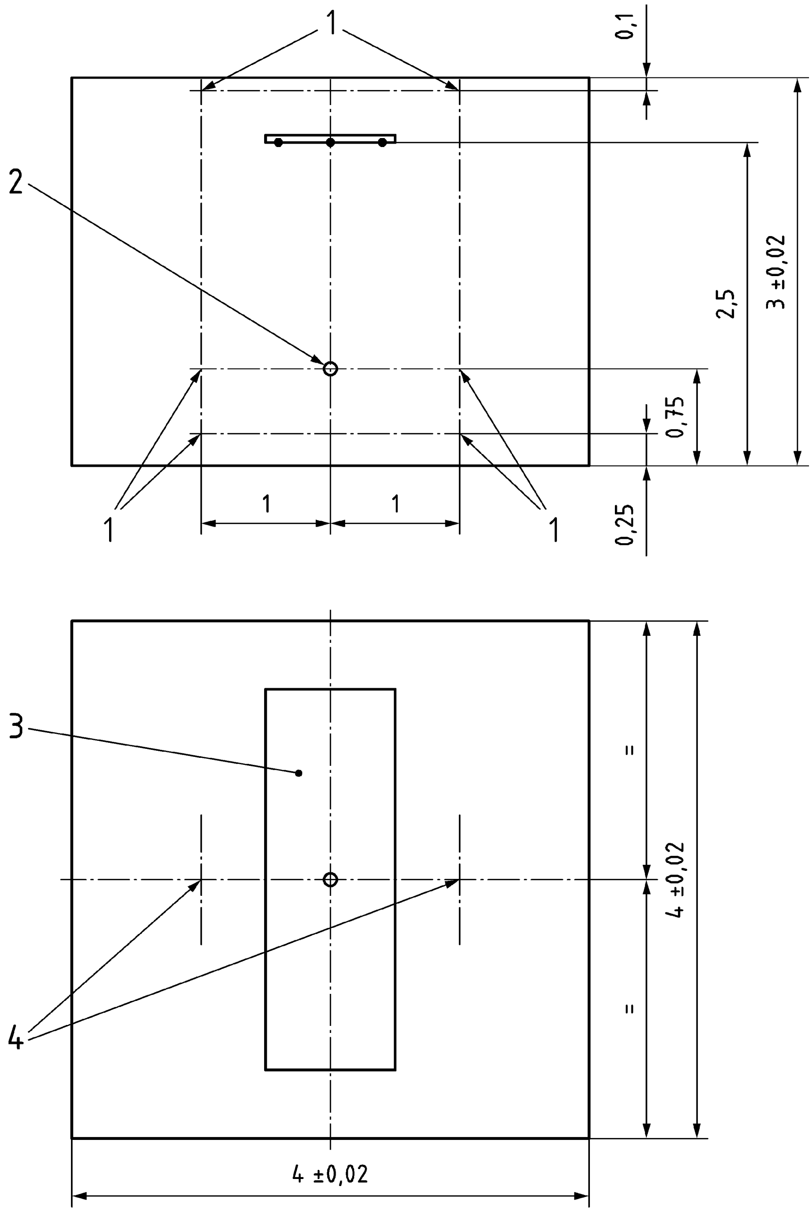

**Key**

1 temperature measuring point

H height of the measuring point

**Figure 3 — Example of a measuring point protected against radiation**

Dimensions in meter




**Key**

1 air temperature measuring points

2 reference room temperature measuring point

3 ceiling mounted radiant panel

4 axes of air temperature measuring points

**Figure 4 — Arrangement of measuring points for the reference room temperature and for air temperature**

### 5.6.3 Surface temperature of the inside surfaces

The surface temperatures of the inside walls is calculated as average value of the inlet and outlet water temperature of each single surface wall.

# 6 Master Panels

## 6.1 Introduction

The master panels which are part of the testing system consist of a model with a full direct heating surface with a width of 1 190 mm (master panel 1) and of a model with 3 tubes and a radiant sheet as indirect heating surface with a width of 300 mm.

## 6.2 General

The purpose of the master panels is the following:

a) to verify if the reproducibility of test values among test laboratories is within the limits set by this European Standard;

b) to establish a common basis for all test installations to verify that the repeatability of test values in each test installation is within the limits set by this European Standard.

To verify the reproducibility among test installations built according to this standard a single set of master panels constructed and verified according to this standard will be circulated among test installations to determine the relevant $\Phi_{M,s}$ and $\Phi_{0,s}$ values. This single set of master panels is named “primary set”.

Each laboratory shall equip itself with the master panel 2 constructed and verified according to this standard. This panel named “secondary set” shall be used to verify the repeatability of the test installation.

## 6.3 Determination of the value $\Phi_{M,s}$ of master panels (Primary set)

The method of determination the value $\Phi_{M,s}$ of the master panel is contained in Annex A.

## 6.4 Construction details

### 6.4.1 Dimensions

The main dimensions of the two master panels are given in the drawings Figures 5 to 10.

### 6.4.2 Material

The master panels shall be constructed from the materials S235 JR.

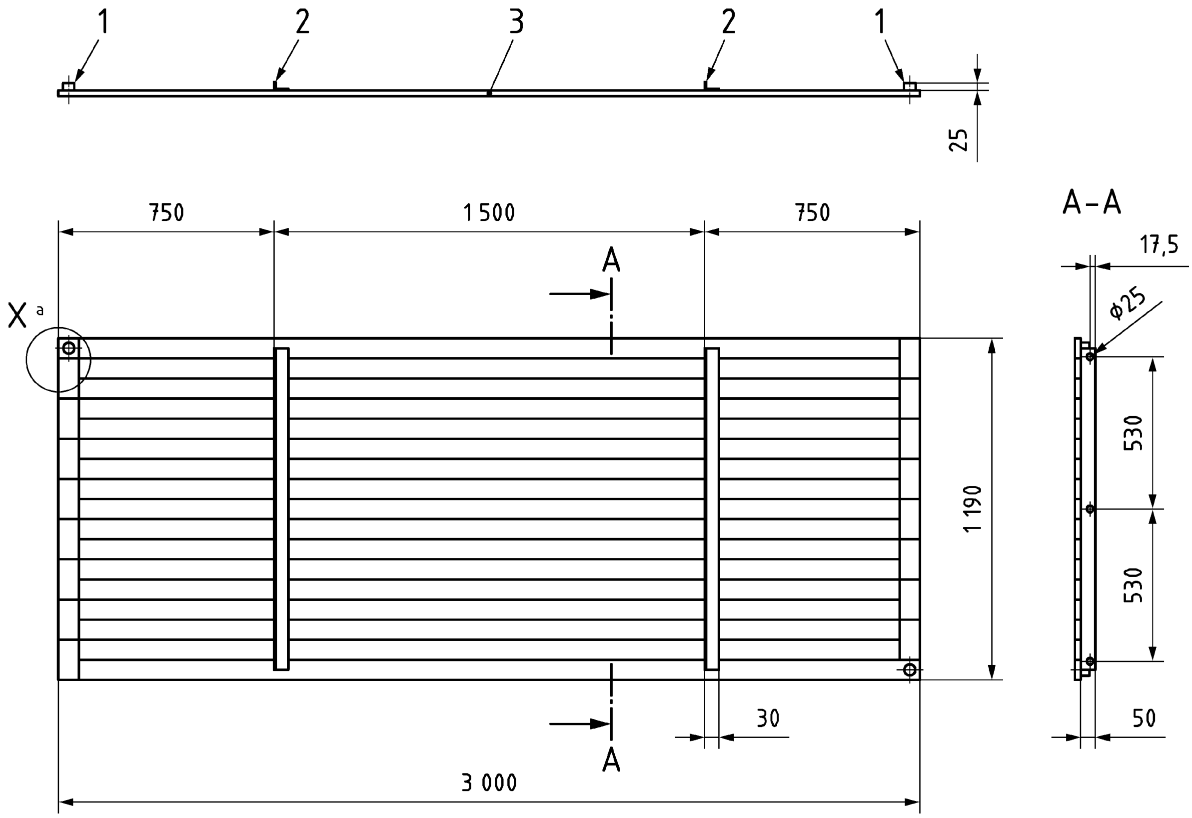
### 6.4.3 Construction

Master panels shall be constructed according to the specifications contained in this standard.

### 6.4.4 Dimensional verification

Master panels shall be dimensionally verified according to the procedure contained in Annex A and a complete report as requested shall be prepared and kept available for any further check.

Dimensions in millimetres




**Key**

a detail B (see Figure 6)

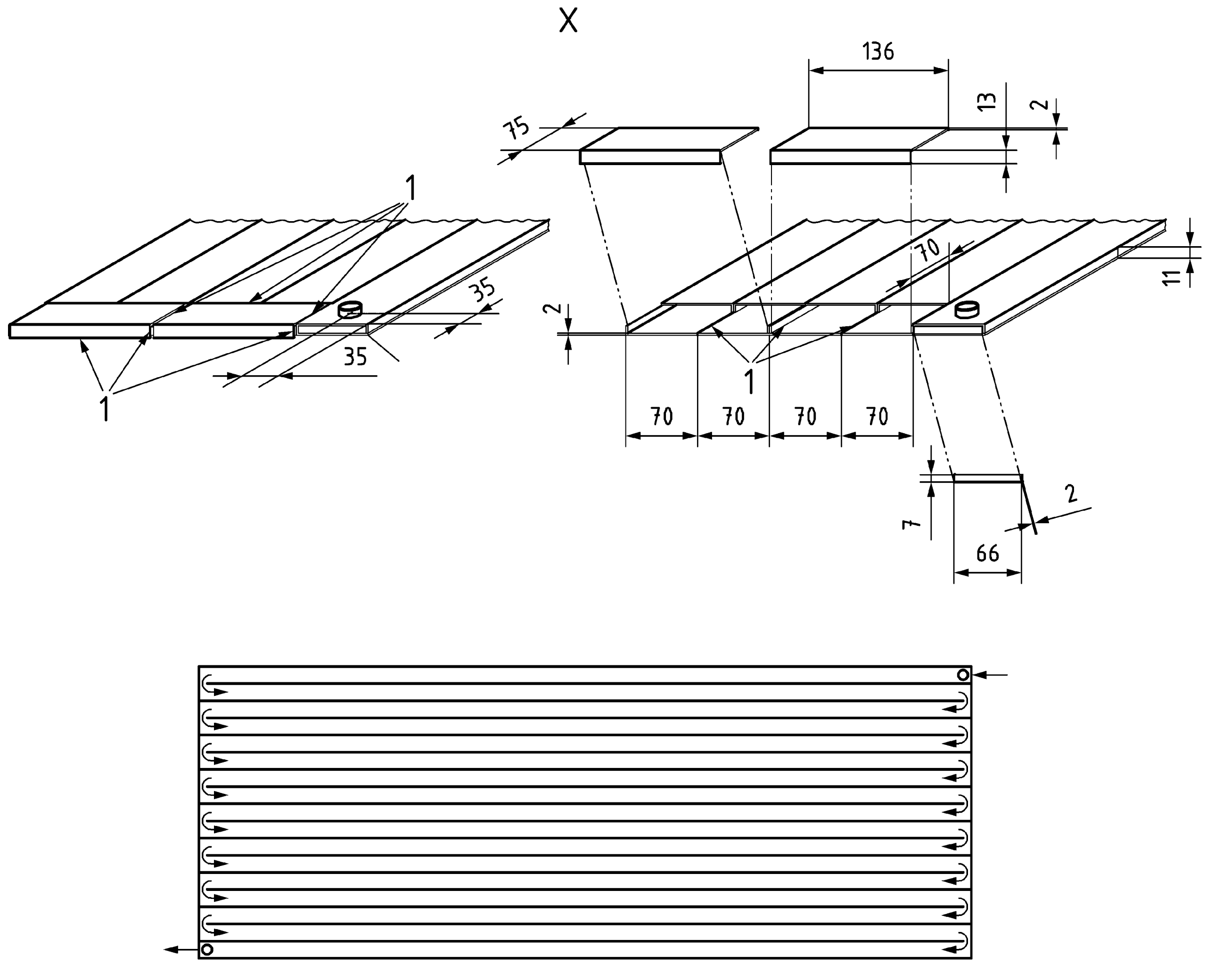
1 female screw socket 1”

2 L-profile 50 mm × 30 mm × 5 mm
length 1120 mm

3 rectangular tube 70 mm × 11 mm × 2 mm

**Figure 5 — Master panel 1, projection and main dimensions**

Dimensions in millimetres



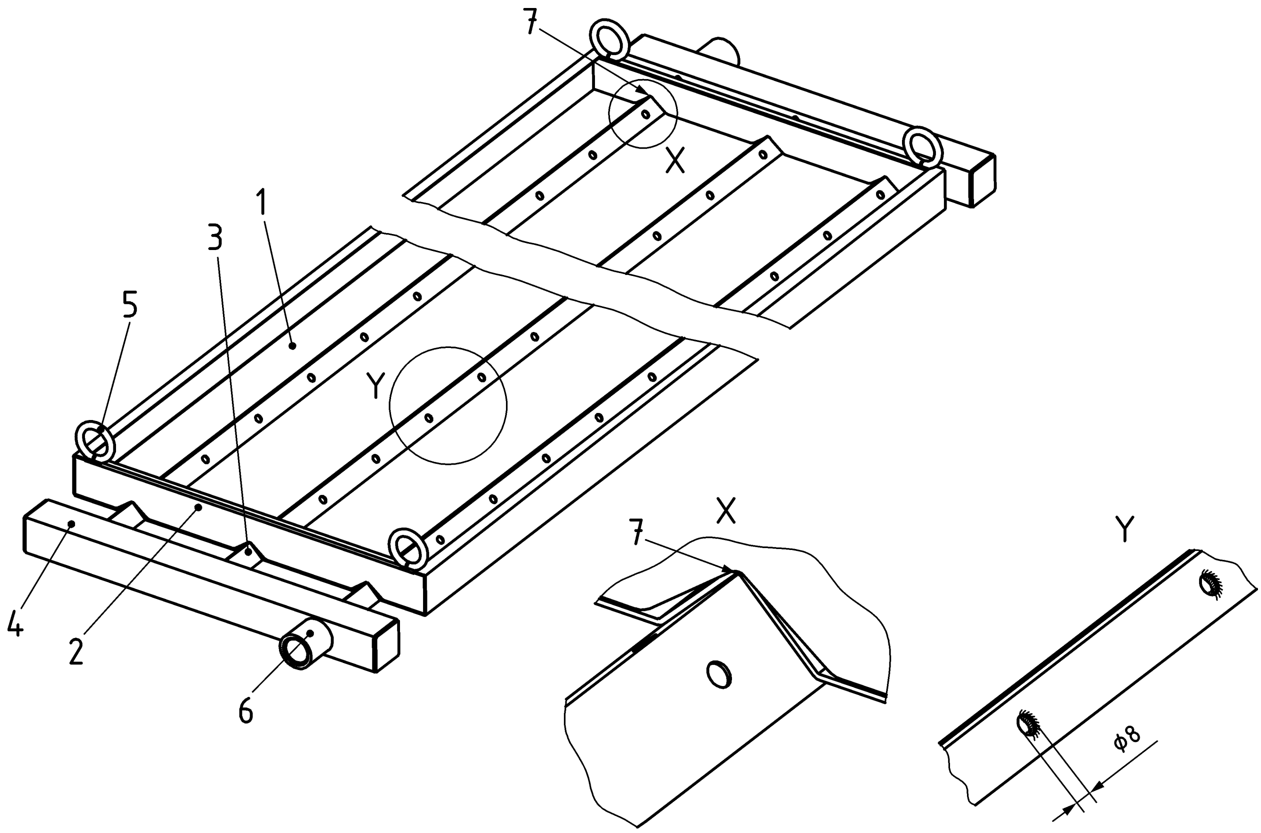

water circulation

**Key**

1 welding

**Figure 6 — Master panel 1, details of headers, water circulation**

Dimensions in millimetres

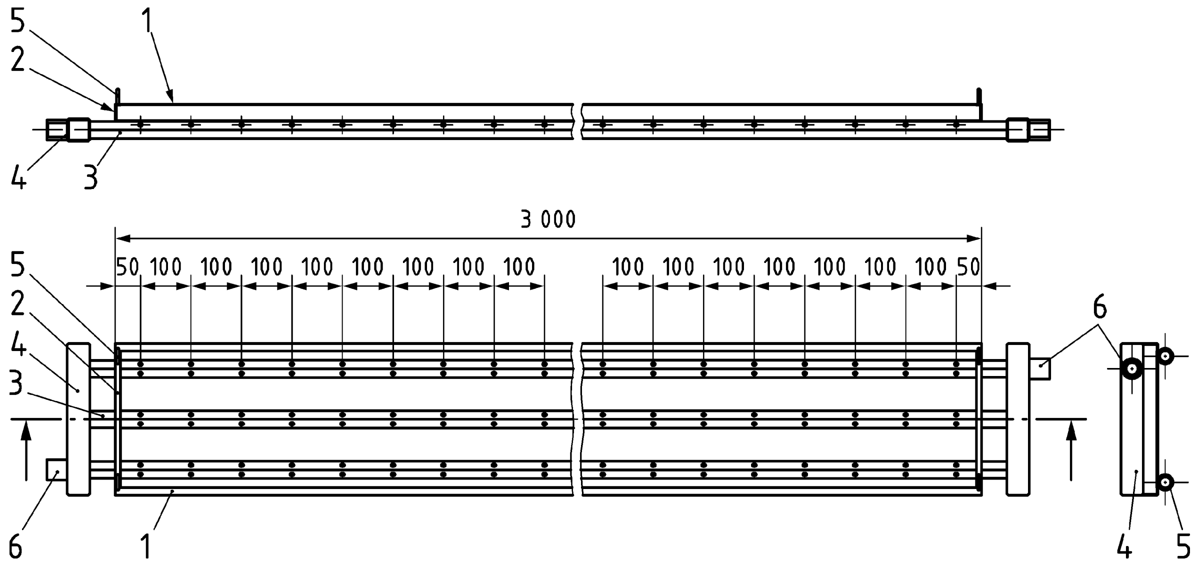



**Key**

| | | | |
|---|---|---|---|
| 1 | radiant sheet s = 1,25 mm | Detail X | lead through of tube register through front sheet |
| 2 | front sheet s = 2,00 mm | Detail Y | bores in the front sheet for hole –welding (30 x) |
| 3 | tube register, rectangular tube 25 mm × 25 mm × 2 mm, EN 10219–2 | | |
| 4 | rectangular tube 45 mm × 45 mm × 2,5 mm, for further information refer to EN 10219–2 | | |
| 5 | eye for suspension welded<br>Ø ext. 32,5 mm; Ø int. 22,5 mm; material Ø 6 mm | | |
| 6 | header connection 1“ female | | |
| 7 | point welding front sheet / radiant sheet (at inner side) | | |

**Figure 7 — Master-panel 2, Isometric view**

Dimensions in millimetres




**Key**

1 radiant sheet s = 1,25 mm

2 front sheet s = 2,00 mm

3 tube register, rectangular tube

25 mm × 25 mm × 2 mm, for further information refer to EN 10219–2

4 rectangular tube 45 mm × 45 mm × 2,5 mm, for further information refer to EN 10219–2

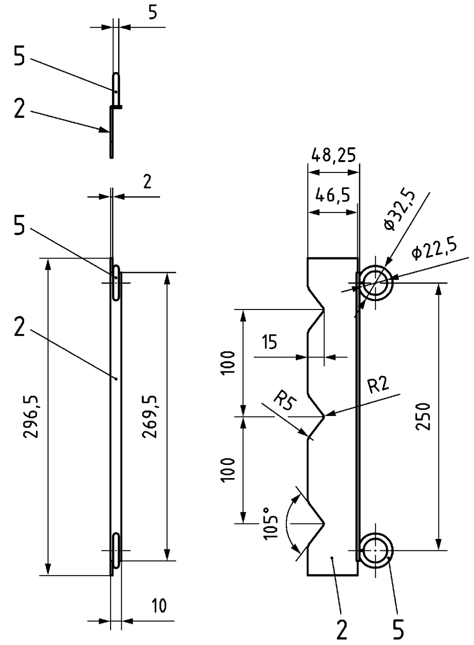
5 eye for suspension welded

Ø ext. 32,5 mm; Ø int. 22,5 mm; material Ø 6 mm

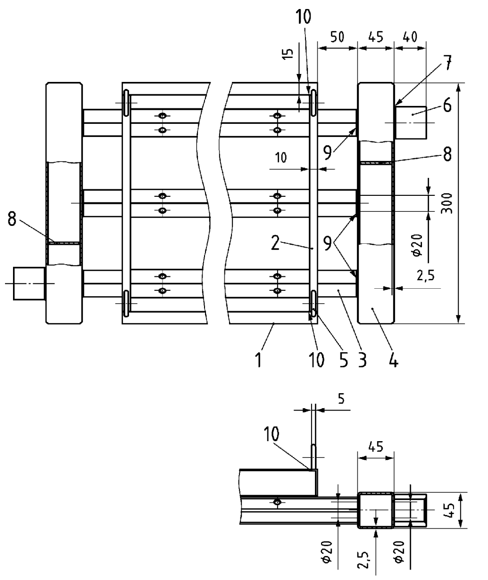
6 header connection 1“ female

**Figure 8 — Master-panel 2, projection and main dimensions**

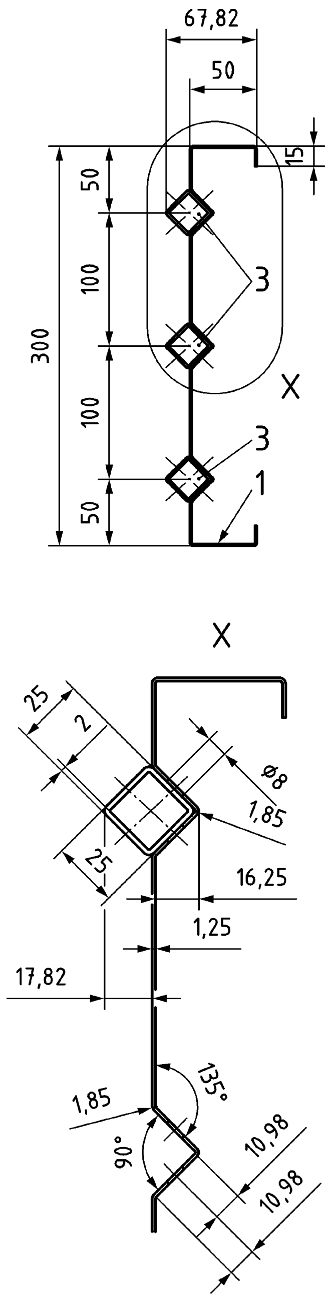
Dimensions in millimetres




**a) Detail front sheet**




**b) Detail connection tube**




**c) detail radiant sheet connection tube**

**Key**

1 radiant sheet s = 1,25 mm

2 front sheet s = 2,00 mm

3 tube register, rectangular tube 25 mm × 25 mm × 2 mm, for further information refer to EN 10219–2

4 rectangular tube 45 mm × 45 mm × 2,5 mm, for further information refer to EN 10219–2

5 eye for suspension welded Ø ext. 32,5 mm; Ø int. 22,5 mm; material Ø 6 mm

6 header connection 1“ female

7 socket welded

8 baffle 100 % tide welded

9 register tube welded

10 point welding front sheet / radiant sheet

**Figure 9 — Master-panel 2, Details of radiant sheet, front sheet and connecting tube**

Dimensions in millimetres

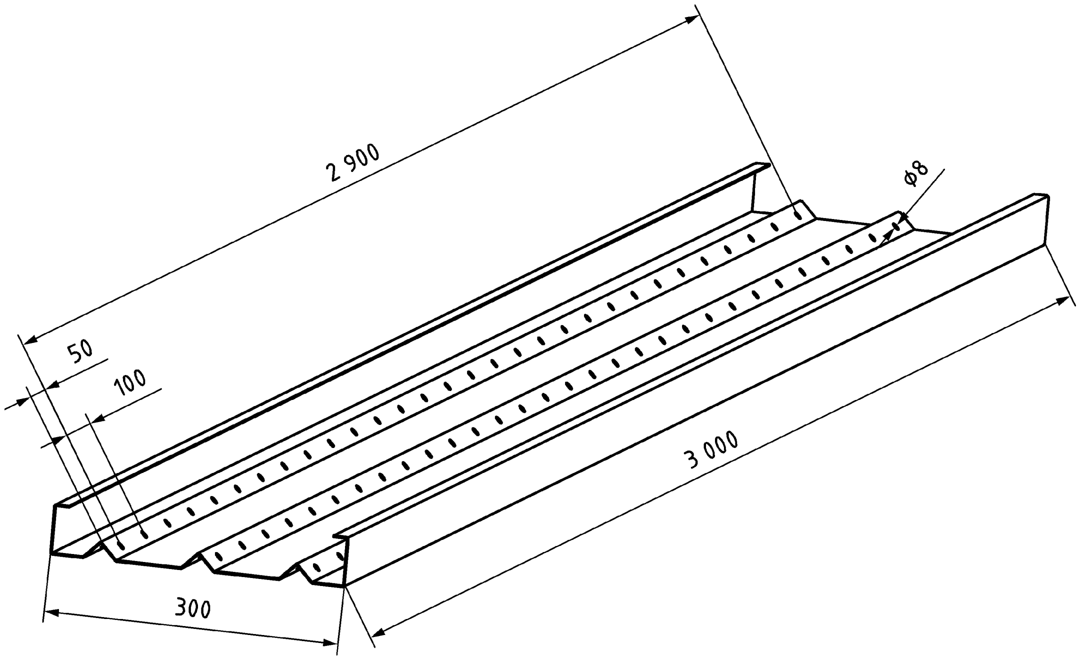



**Figure 10 — Master-panel 2, Detail of radiant sheet**

### 6.5 Verification of test installation, repeatability and reproducibility

All test installations shall be verified for:

— Constructional conformity: The laboratory shall state the conformity according to this standard. Any statement concerning thermal outputs shall be accompanied by a statement indicating the test conditions in which the stated outputs have been obtained;

— Repeatability: The repeatability precision shall be within an allowed tolerance $s_0$ when testing a single master panel in the same test installation at short or long intervals. The testing laboratory will use its own master panel (secondary set) to determine the repeatability tolerance $s_0$ of the test installation. Using this master panel, heat output tests shall be carried out in accordance with Clauses 7 and 8. The latest test for repeatability shall not have taken place longer than 6 month before a thermal heat output test. The repeatability shall be tested every 12 month in minimum. To prove the repeatability precision of a test laboratory, the results of five consecutive tests at the starting of the test installation shall be within a tolerance range $s_0$ = 20 W according to 8.10;

— Reproducibility: The reproducibility shall be proved by using the primary set of master panels. The test results (carried out in accordance with 8.10) shall be within the tolerance $s_m$ = ± 20 W of the $\Phi_{M,s}$-value of each master panel.

The test laboratories have to proof the reproducibility in periodical tests.

## 7 Test methods

### 7.1 General

The aim of the thermal output test is to establish the standard characteristic equation of a ceiling mounted radiant panel by determining the related values of thermal output and temperature difference. Neither of these quantities can be measured directly, but shall be calculated using the values of other measurable quantities, either directly or with additional information (calibration test, material properties table), by using mathematical relationships.

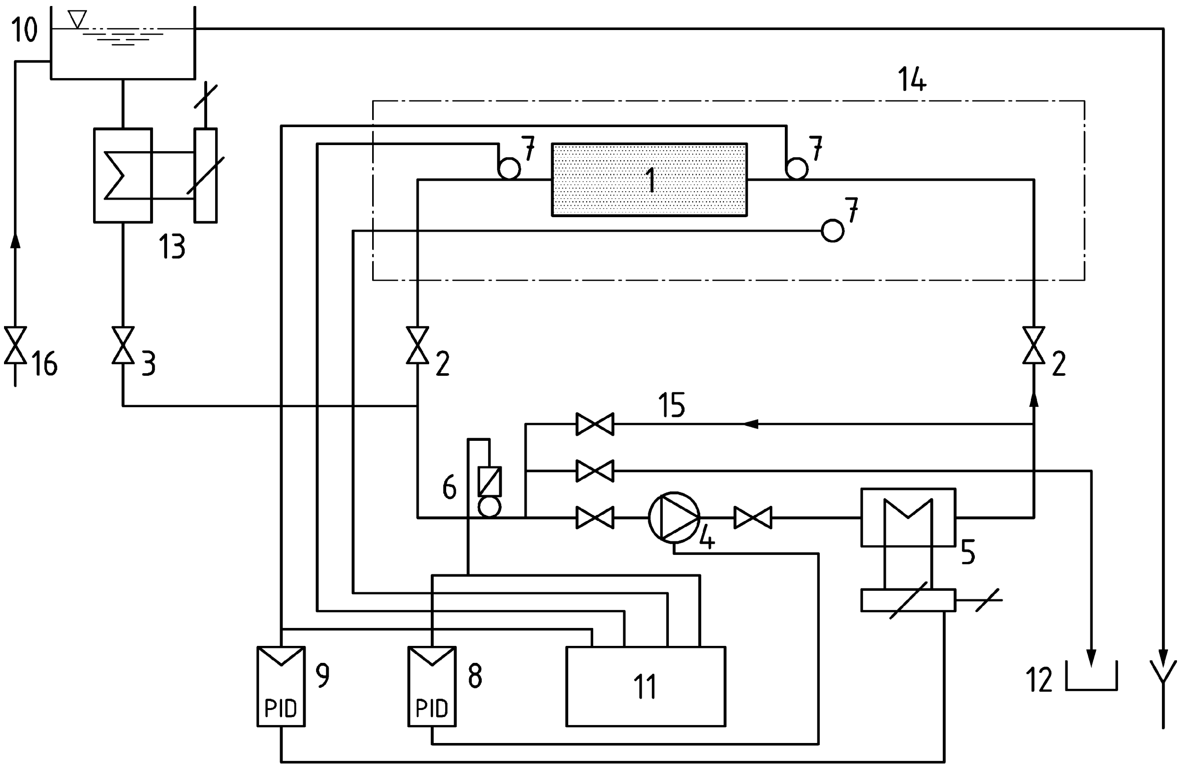
Related to the evaluation of the standard characteristic equation, characteristics with deviating terms for the upper insulation (see 8.6), for the mass flow (see 8.9) or the temperature range (see 8.10) can be evaluated in addition to the standard output test. The results of the additional tests have to be documented in the test report of the standard measurement.

## 7.2 Weighing method

The thermal output $\Phi_{me}$ is calculated based on the water flow rate $q_m$ and the measured temperatures $t_1$ and $t_2$. These temperatures are used to calculate the specific enthalpies as determined by the international steam tables at a reference water pressure of 120 kPa:

$$\Phi_{me} = q_m (h_1 - h_2)$$

The water flow rate is measured directly by a calibrated flow-meter in a closed water circuit (see Figure 11) or calculated using the mass of the water *m* collected in a measuring vessel and the relevant time interval $\tau$ (see EN 442-2).




**Key**

1 panel in the test booth
2 water circuit for measurement
3 connection of the calibration device to the measuring circuit
4 circulating pump in the measuring circuit (controlled)
5 electric heating element in the measuring circuit for flow temperature control
6 mass flow measuring instrument
7 temperature measuring points
8 control unit for mass flow
9 control unit for flow temperature
10 container with overflow for calibration device
11 recording- and evaluating instruments
12 collecting- and draining installation for calibrating measurement
13 heating device for calibrating measurement
14 test booth
15 bypass
16 water supply for calibration device

**Figure 11 — Basic diagram of test installation with continuous measurement of the mass flow (weighing method) and with a device for calibrating the measuring instrumentation**

## 7.3 Measurement of the inlet and outlet temperatures

The bulk temperature of the water at inlet and outlet shall be measured with a device which ensures a sufficient accuracy. This result can be reached for example by a measuring device according to Annex B.

## 7.4 Measurement of the control temperatures

All temperatures which do not serve for the determination of the thermal output shall be measured with an accuracy of ± 0,1 K.

## 7.5 Uncertainty of the measured thermal output

The maximum uncertainty in measuring the thermal output shall not exceed ± 10 W.

## 7.6 Air pressure

The air pressure is measured with a tolerance of ± 2 hPa.

# 8 Carrying out the measurement

## 8.1 General

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

## 8.2 Dimensions and construction of the test samples

The active length of the ceiling mounted radiant panels without the connection components shall be within the range of 2,9 m to 3,1 m, the width shall be within a range of 0,3 m to 1,5 m. The construction length including the connection components shall be max. 3,5 m. No elements which could increase the heat output shall be added to the linkage between the active length and the collectors/headers.

The tubes of the radiant ceiling panels shall be placed individually in series. The upper insulation is installed by the test laboratory according to 8.6.

## 8.3 Selection of the models to be tested for determining the thermal output of a type

For determining the thermal output of a type the models with the smallest and largest width within the range according to 8.2 are to be tested at least. Interpolation of thermal output and exponent is allowed if the proportion of width of two tested panels does not exceed 2. Interpolation shall be linear.

## 8.4 Manufacturer documents for the test samples

The manufacturer shall provide for each test sample a drawing containing all dimensions and other characteristics which will have an influence on the thermal output. This also includes all details about welding or other methods of bonding.

The drawing shall also contain all the details of material used and of the nominal wall thickness of wet and dry surfaces, as well as the specification of the surface treatment applied.

The manufacturer shall provide in writing:

— report of emissivity as described in EN 14037-3:2016, 4.2;

— all technical data as listed in EN 14037-1:2016, 7.6.

The manufacturer shall declare that the sample supplied has been manufactured with the same methods and materials as the models of the standard production.

In cases where the test sample has not been manufactured by the applicant, a written declaration of product identity, which will be added to the test report of the test laboratory, has to be submitted.

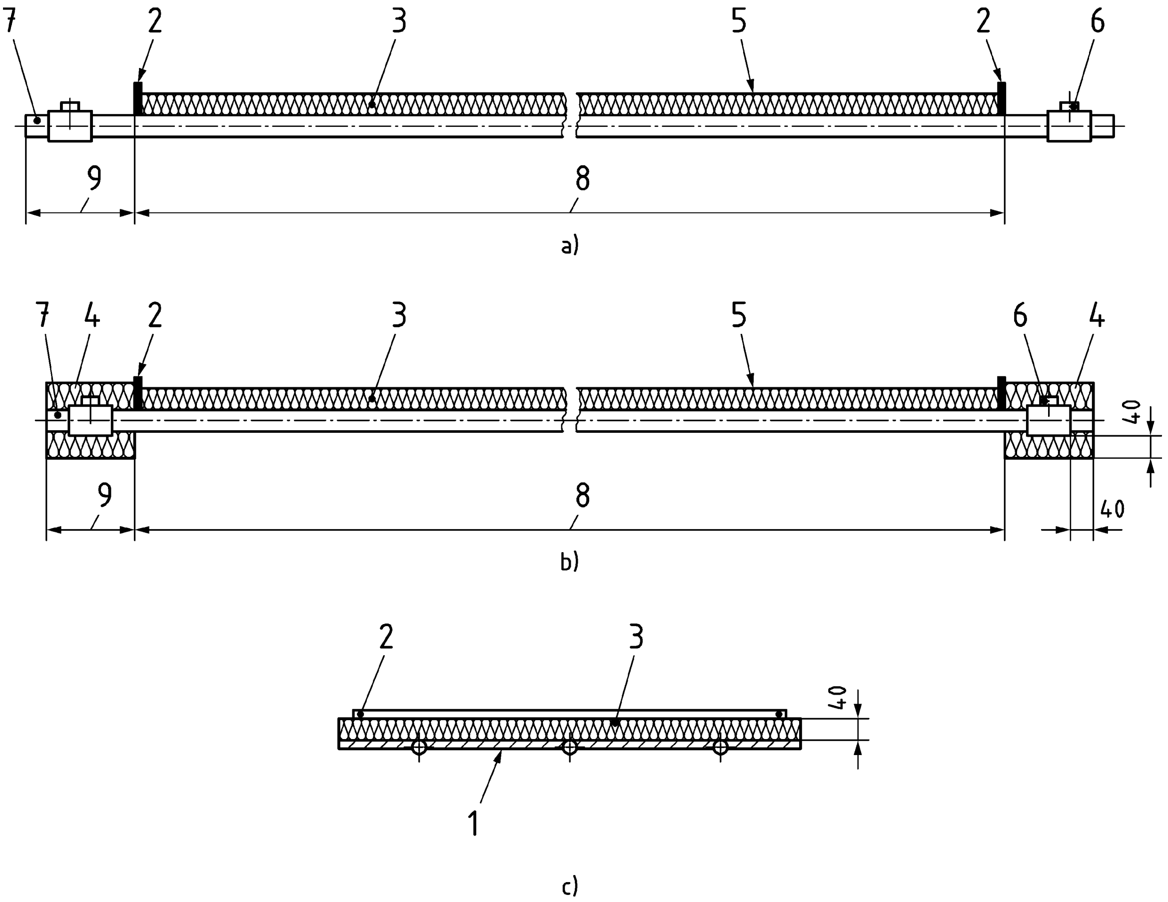
Instead of information concerning the manufacturer and the designation of product, reference to the above mentioned declaration shall be made in the test report.

## 8.5 Arrangement of the sample in the test booth

The ceiling mounted radiant panel to be tested shall be installed horizontally. It shall be installed symmetrical to the centre axes of the test booth (see Figure 4). The lowest point of the radiating surface shall be (2,5 ± 0,02) m above the floor. It shall be installed with the connection components.

When measuring the thermal output of the active length, these components shall be provided completely insulated as shown in Figure 10, the characteristics shall be as described in 8.6. Examples for the insulation of the connection components are shown in Figure 13. The insulation has to be thick all-over 40 mm. Is the distance between header and active length below 40 mm, the insulation has to cover the respective part of the active length. When determining the thermal output of the module, only the free part of the active length will be considered. When determining the thermal output of the connecting components the output of the effective active length will be calculated with the characteristic equation.

Dimensions in millimetres




**Key**

a) longitudinal section insulation for the test with not insulated connection components

b) longitudinal section insulation for the test with insulated connection components

c) cross section

1 bottom edge of the ceiling mounted radiant panel

2 fixing point

3 heat insulation

4 heat insulation of the connection components (also integrated between the pipes)

5 aluminium foil

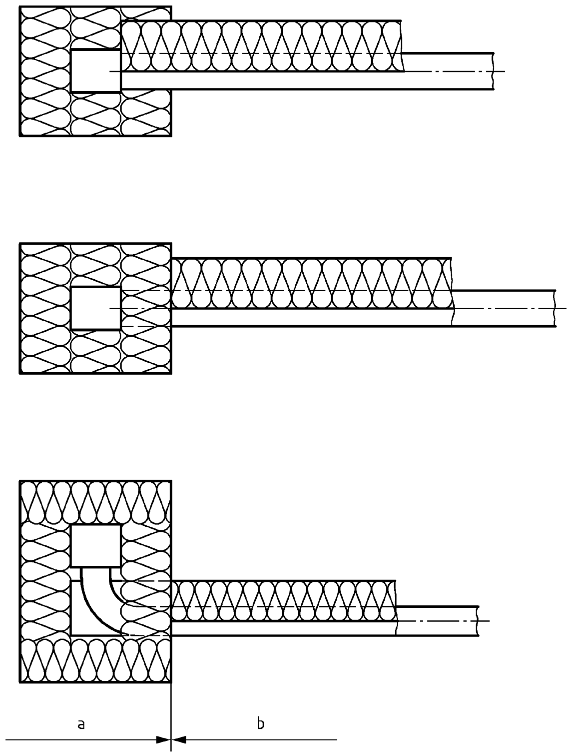
6 venting

7 connection to distribution pipe

8 active length of the ceiling mounted radiant panel

9 connection component

**Figure 12 — Arrangement of insulation for testing**




**Key**

a connecting component

b active length

**Figure 13 — Example for the insulation of connection components**

## 8.6 Upper insulation of the test sample

The upper insulation to be provided by the laboratory for the test of the standard output is defined as follows: layer of 40 mm mineral wool with vertical fibre, covered with aluminium foil, heat conductivity 0,04 W/mK at 40 °C, density minimum 25 kg/m³. The insulation shall be placed on the upper side of the test panel without any interruption, aluminium foil at top. Upwards standing components like braces and suspension bars etc. have to be respectively insulated.

In ceiling mounted radiant panels with a heat-insulating layer in combination with active heating surface on top, the upper insulation as described before, has to be installed in addition for the measurement of the standard thermal output.

## 8.7 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.

## 8.8 Tests

The measuring of the thermal output of a model shall be done with two tests. At both tests the upper insulation shall be provided in accordance with 8.6.

Test 1 is made to evaluate the thermal output of the active length. The connection components shall be insulated in accordance with 8.5.

Test 2 is to evaluate the total thermal output. Therefore the insulation of the connection components shall be removed.

## 8.9 Mass flow

The water flow rate shall be regulated so that a Reynolds value Re = 4500 ± 500 results in the tubes of the ceiling mounted radiant panel at a water temperature of 50 °C. 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.

## 8.10 Test temperatures

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

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

— 48 °C to 52 °C;

— 68 °C to 72 °C;

— 88 °C to 92 °C.

## 8.11 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 the 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 % |

## 8.12 Correction due to the air pressure

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

$$\Phi = \Phi_{me}\left(0,65 + 0,35\left(\frac{p_s}{p}\right)^{0,4}\right)$$

## 8.13 Result of measurement – Characteristic equation

Having been corrected according to 8.12 the values of the thermal output are plotted over the measured values of temperature difference 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 active length $\Phi_{act} = K_{act} \cdot \Delta T^{n_{act}}$

— Characteristic equation of the total length $\Phi_{tot} = K_{tot} \cdot \Delta T^{n_{tot}}$

The constants $K_{act}$ respectively $K_{tot}$ and the exponents $n_{act}$ respectively $n_{tot}$ are determined by regression according to Annex C. The standard output is calculated from the function of the characteristic equation.

The characteristic equation of the connection components is formed by subtraction of the characteristic equation of the total length and the one of the active length. The subtraction is carried out for 30 K, 50 K and 70 K. The constant $K_{comp}$ and the exponent $n_{comp}$ are determined in the same way as for the other equations. When determining the thermal output of the connection components 8.5 has to be followed if applicable.

# 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. The example of the test report is shown in Annex D.

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 EN 14037-1:2016, 3.3.1.

## 9.2 Data

The following data shall be 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 the 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) documents of the manufacturer (drawing no, report of the pressure test, report of the factory test) confirmation of the producer or declaration of product identity (according to 8.4 of this standard);

i) test results:

   1) results of the resistance to pressure test according to EN 14037-1:2016, 5.8;

   2) results of the control of the general construction specifications according to EN 14037-1:2016, 5.1;

   3) results of the control of the dimensional tolerances, according to EN 14037-1:2016, Table 2, all dimensions of the test sample shall be documented with the nominal dimension, the measured dimension, nominal tolerance and the measured differences in a table;

   4) Test data (see Annex D) including e.g. water temperatures, air temperatures, globe temperature, water flow rate, corresponding Reynolds number at 50 °C;

   5) standard total output and the characteristic equation of the tested panel;

   6) standard output and the characteristic equation of the active length of the tested panel;

   7) standard output and the characteristic equation of connection components of the tested panel;

8) standard modular output and exponents of the tested panels and the interpolated/calculated panels;

9) rated thermal output (see EN 14037-3:2016) of the tested panel and the interpolated/calculated panels;

10) for characteristic equation with deviations from the standard characteristic equation;

11) exact description of the deviating condition: parameters, thermal output values of standard temperature difference, equation for the characteristic.

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.

# Annex A
(normative)

# Dimensional verification of master panels

## A.1 General

After having been painted, master panels shall be dimensionally verified using the relevant form of this Annex (see Figures 5 to 8).

The arithmetical mean value of each dimension shall be within the limits indicated in the form.

The measured mass and water content shall be reported in the form.

The filled in form shall be made available by the laboratory for any further check.

## A.2 Determination $\Phi_{M,s}$ -values of the master panels (primary set)

The $\Phi_{M,s}$ – value of a master panel of the primary set will be determined by a round robin measurement of all laboratories participating at the testing system. The procedure and the round robin measurement will take place under the supervision of a Working Group 7 of CEN/TC 130. Each laboratory determines the $\Phi_{0,s}$ -value as an average of five consecutive measurements (Test results to 8.13). All test results shall be within the tolerance $s_0$ = 20 W. The value $\Phi_{M,s}$ will be formed by the working group 7 of CEN/TC 130 as an average from the $\Phi_{0,s}$ -values of the laboratories, whereby no $\Phi_{0,s}$ -value shall be used, which differs more than ± 20 W from the average value of all laboratories.

## A.3 Dimensional verification and manufacturing certification for master panel 1

The manufacturer has to present the following confirmations and samples concerning the fabrication of the master panel 1:

| | |
|---|---|
| Profiled material of square tube 70 × 11 mm: | - Dimensional tolerances of the tube producer for tube dimensions and wall thickness. |
| | - Tube sample from the fabrication of the master panel. |
| Fabrication of the headers: | - Fabrication and welding according to Figure 6. |
| Surface treatment: | - Designation of the applied coating including confirmation of the emissivity according to EN 14037–3:2016. |

On the finished master panel the following dimensions are to be checked regarding the tolerances as stated in Table A.1.

**Table A.1 — Dimensional verification of master panel 1**

| | Length $L$/mm | Width $W$/mm | Height $S$/mm | Length $T$/mm | Length $A$/mm | Socket $X$/mm |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | ---- | ---- | | ---- | | ---- |
| 4 | ---- | ---- | | ---- | | ---- |
| Average | | | | | ---- | ---- |
| Max. value | 3 001 | 1 191 | 11,5 | 1 122 | 748 | 28 |
| Min. value | 2 999 | 1 189 | 10,5 | 1 118 | 752 | 25 |
| Assessment | | | | | | |

Additionally the following has to be checked:

— observance of the nominal dimensions of the fixing profiles (L50 × 30 × 5mm);

— observance of the nominal dimensions of the tube profile according to manufacturer's specification and sample (70 × 11 × 2 mm);

— water circulation / tube circuit according to Figure 6, based on the position of welds at the headers; arrangement of the connections;

— dry mass in kg;

— water content in kg.

Dimensions in millimetres

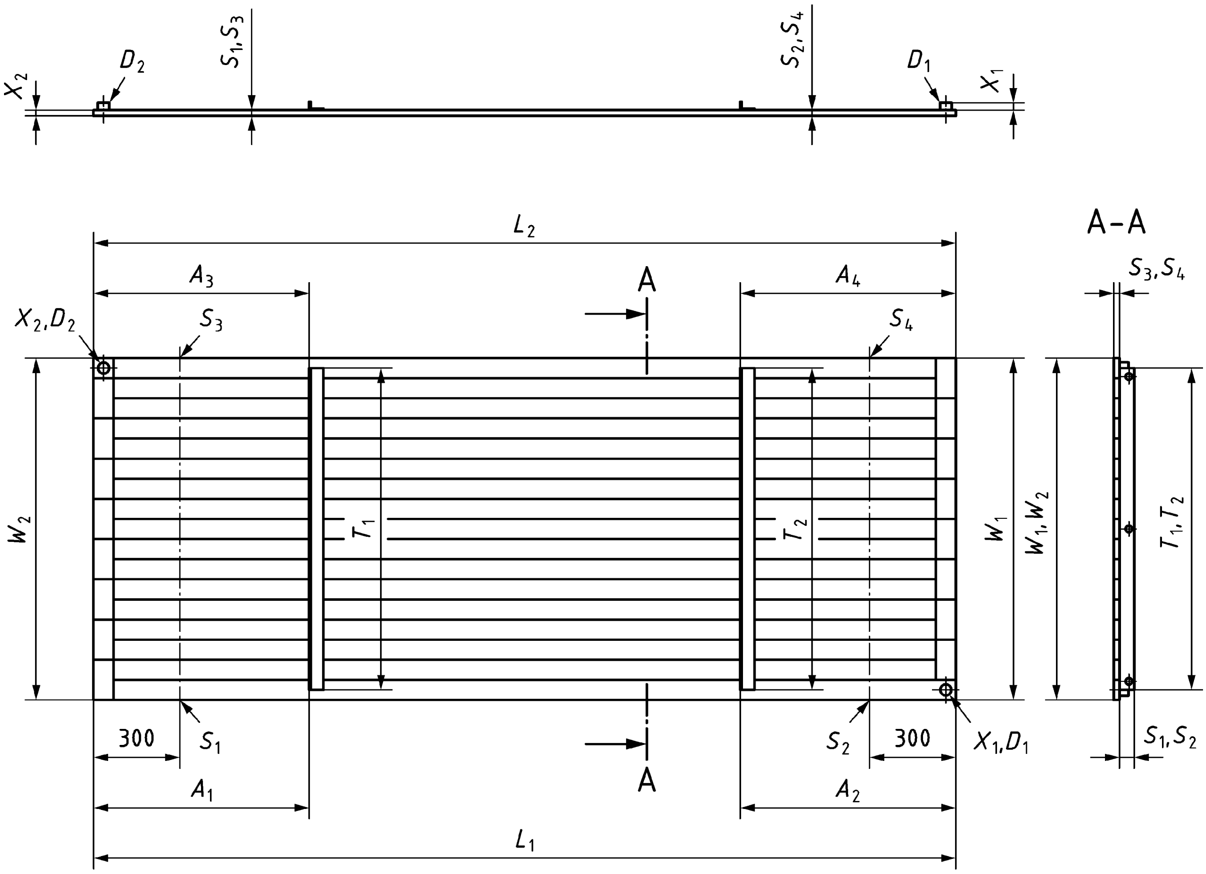



**Figure A.1 — Dimensional verification for master panel 1**

## A.4 Dimensional verification and manufacturing certification for master panel 2

The manufacturer has to present the following confirmations and samples concerning the fabrication of the master panel 2:

| | |
|---|---|
| Material of tubes and sheet steel for heating coil, headers and radiating sheets: | - Dimensional tolerances of the tube producer for tube dimensions and wall thickness. |
| | - Tube and sheet steel sample from the fabrication of the master panel. |
| Fabrication of the headers: | - Fabrication and welding according to Figures 7 to 9. |
| Surface treatment: | - Designation of the applied coating including confirmation of the emissivity according to EN 14037–3:2016. |

On the finished master panel the following dimensions are to be checked regarding the tolerances as stated in the table below.

**Table A.2 — Dimensional verification of master panel 2**

| | Length $L$/mm | Width $W$/mm | Height $S$/mm | Dis-tance $B$/mm | Dis-tance $T$/mm | Length $LE$/mm | Length $F$E/mm | Length $H$/mm | Socket $X$ /mm | Socket $D$/ 1 “ | bead $Y$/mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | ---- | ---- | | | | | | ---- | ---- | ---- | |
| 4 | ---- | ---- | | | | | | ---- | ---- | ---- | |
| 5 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | |
| 6 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | |
| Average | | | | ---- | | ---- | ---- | ---- | ---- | ---- | |
| Max. value | 3 001 | 301 | 51 | 51 | 99 | 21 | 10,5 | 301 | 28 | ---- | 16,75 |
| Min. value | 2 999 | 299 | 49 | 49 | 101 | 19 | 9,5 | 299 | 25 | ---- | 15,75 |
| Assessment | | | | | | | | | | | |

Additionally the following has to be checked:

— observance of the nominal dimensions of the tube profiles and thickness of the sheet steel according to manufacturer's specification and sample;

— water circulation / tube circuit according to Figure 9b), based on the position of welds at the inlet and outlet headers; arrangement of the connections;

— dry mass in kg;

— water content in kg.

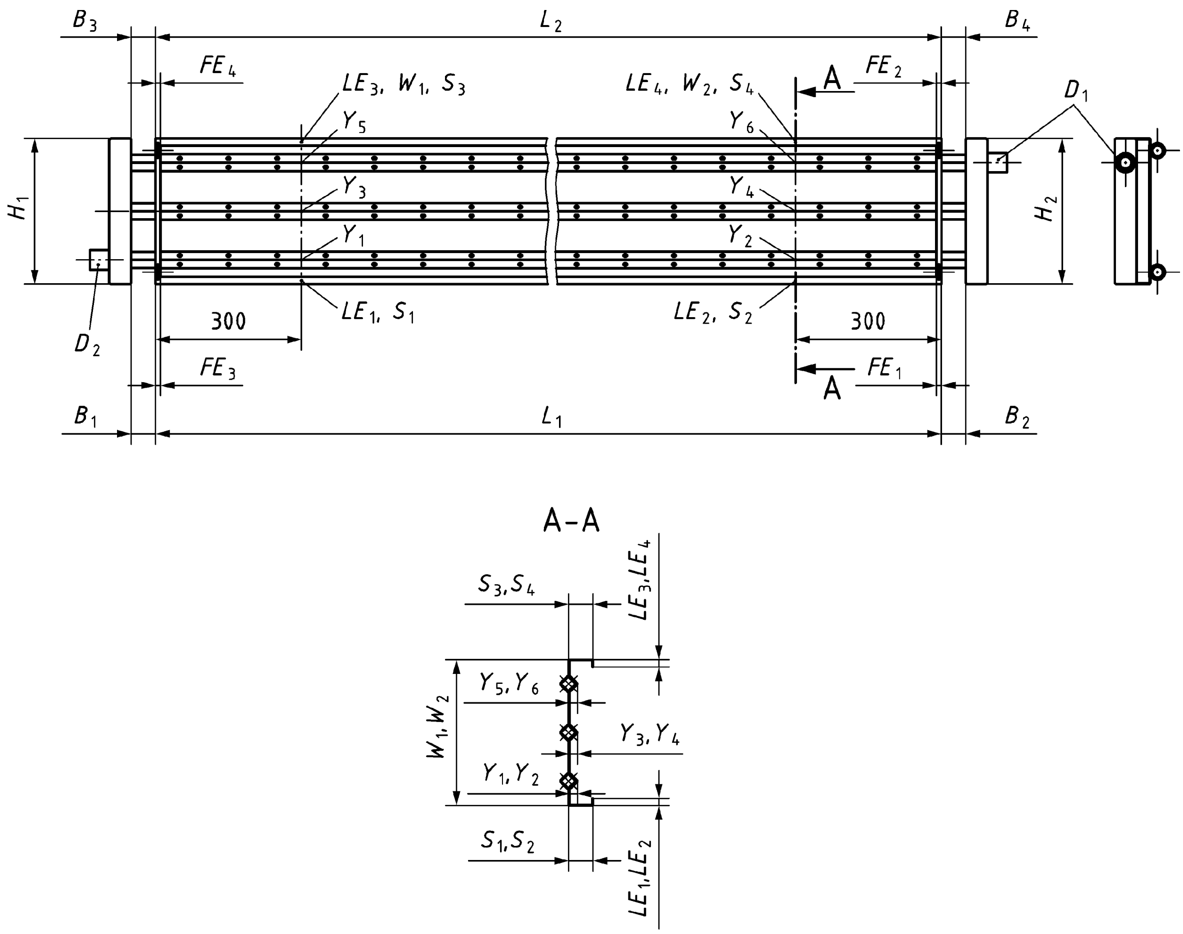



**Figure A.2 — Dimensional verification for master panel 2, main dimensions**

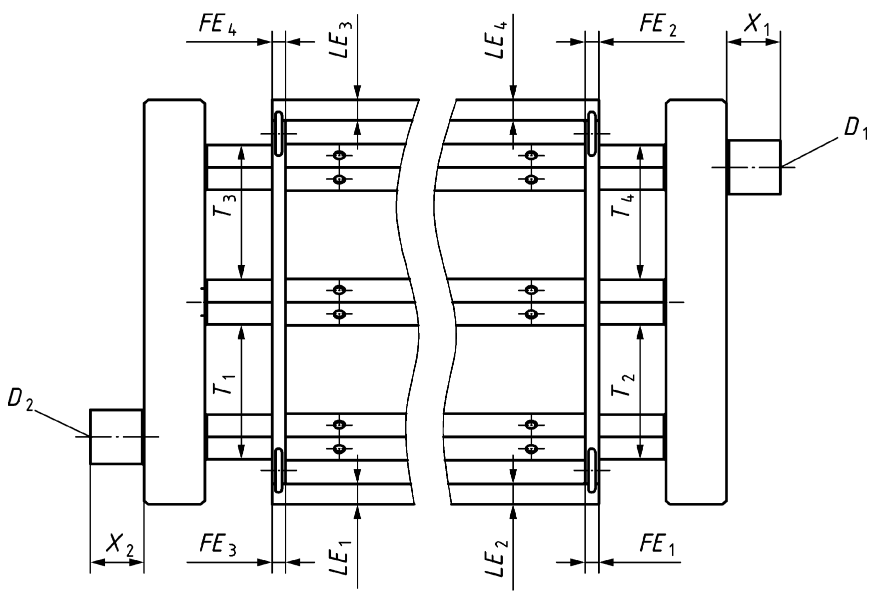



**Figure A.3 — Dimensional verification for master panel 2, headers, tube register, radiant sheet**

# Annex B
(informative)

# Temperature measuring device

Dimensions in millimetres

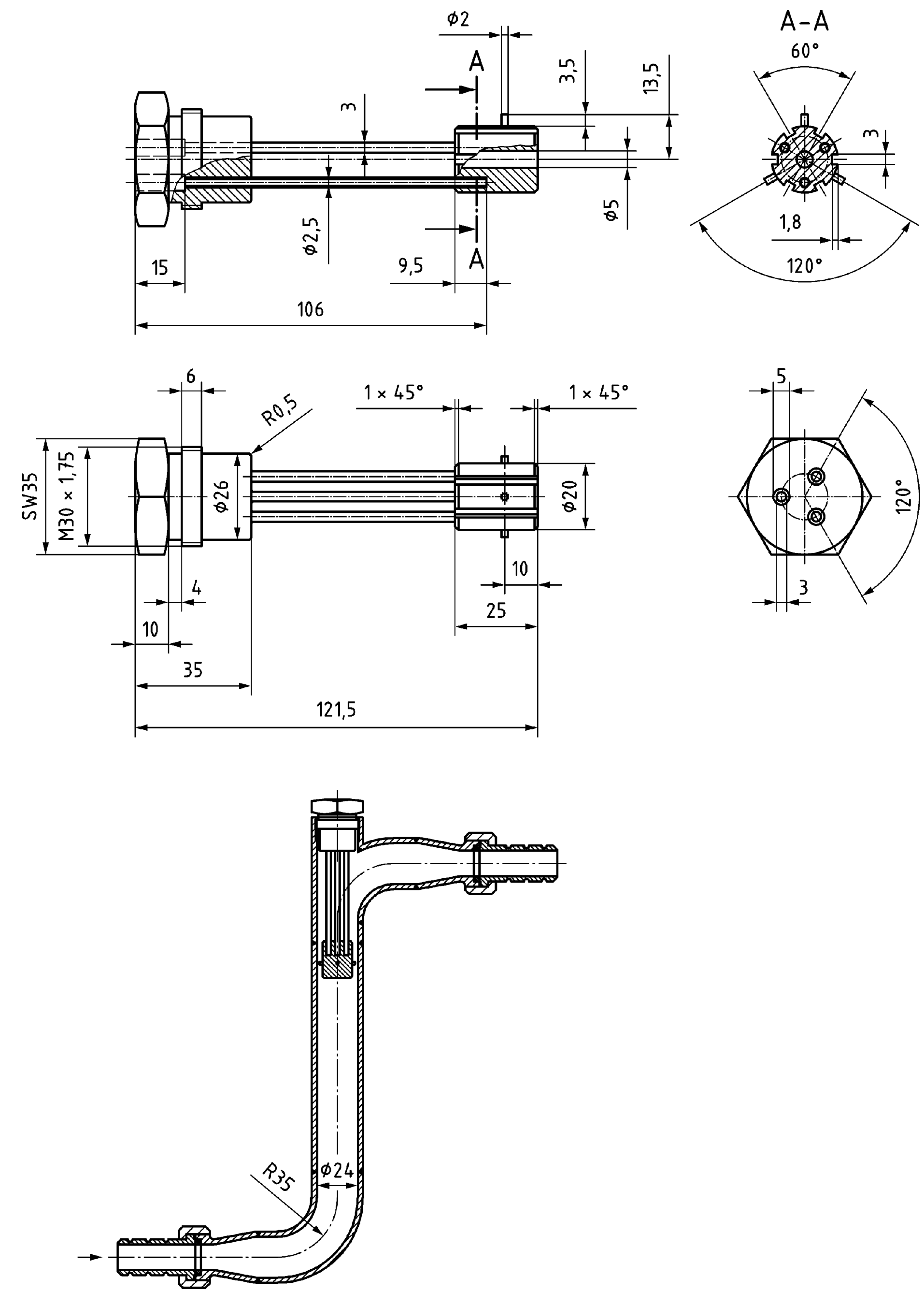



**Figure B.1 — Temperature measuring device**

# Annex C
(normative)

## Least squares regression for a model

The characteristic equation: $\Phi = K \cdot \Delta T^{n}$

becomes in logarithmic coordinates:

$$\log \Phi = \log K + n \cdot \log \Delta T$$

Applying the last squares method the log *K* and *n* values are obtained as follows:

$$\log K = \frac{\sum(\log \Phi) \cdot \sum\left[(\log \Delta T)^2\right] - \sum(\log \Delta T \cdot \log \Phi) \cdot \sum(\log \Delta T)}{N \sum\left[(\log \Delta T)^2\right] - (\sum \cdot \log \Delta T)^2}$$

$$n = \frac{N \sum\left[(\log \Delta T \cdot \log \Phi)\right] - \sum(\log \Delta T) \cdot \sum(\log \Phi)}{N \sum\left[(\log \Delta T)^2\right] - (\sum \cdot \log \Delta T)^2}$$

where

*N* is the number of test points

# Annex D
(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 −3.

data of the test sample: (active length, active 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, maximum operating pressure, maximum temperature, dry mass, water content).

.......................................................................................................................................................................................................................

documents of the manufacturer (drawing no, report of the pressure test, report of the factory test) confirmation of the producer or declaration of product identity (according to 8.4 of this standard)

---

manufacturers trademark (identification): .........................................................................................................

Identification of the type: .........................................................................................................................

The type comprises the following models (in case of a single model indicate the model only):

| **Model** | **Width**<br>mm | **Active length**<br>mm | **Number of tubes** | **Drawing no.** | **Tested (Y/N)** |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

Signature of the Test Engineer and the Laboratory Director

........................ ................................

**Standard thermal outputs and exponents n of the models**

| Model | Width<br>mm | Active length<br>mm | Thermal output of the active length<br>W | Exponent n | Standard modular thermal output<br>W/m | Rated modular thermal output<br>W/m |
|---|---|---|---|---|---|---|

**Results of test 1 resp. 2 (for each tested model)**

| | Symbols | unit | measuring points | | |
|---|---|---|---|---|---|
| | | | 1 | 2 | 3 |
| 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 | $\Delta T$ | K | | | |
| Water flow rate | $q_m$ | kg/s | | | |
| Measured output | $\Phi_{me}$ | W | | | |
| Output corrected for barometric pressure | $\Phi$ | W | | | |

Characteristic equation of the tested model: $\Phi = K_m \times \Delta T^n$

where

$K_m$ = ......................

$n$ = ..............................

**Report of the determination of the characteristic equation from the connecting components**

| | unit | Calculation points | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Temperature difference | K | 30 K | 50 K | 70 K |
| Total output (test 2) | W | | | |
| Output of the active length (test 1) | W | | | |
| Output of the connection components | W | | | |

**Control temperature for test 1 resp. 2**

| | unit | Measuring points | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Air temperature 0,25 m above floor, on the side of inlet | °C | | | |
| Air temperature 0,25 m above floor, on the side of outlet | °C | | | |
| Air temperature 0,75 m above floor, on the side of inlet | °C | | | |
| Air temperature 0,75 m above floor, on the side of outlet | °C | | | |
| Air temperature 0,10 m under the ceiling, on the side of inlet | °C | | | |
| Air temperature 0,10 m under the ceiling, on the side of outlet | °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 | | | |

**Control of the dimensional tolerances of the sample**

| Dimension | unit | measuring | | | Mean | Nominal dimension (manufacturer) | Tolerance | Measured max. difference | Difference in limit |
|---|---|---|---|---|---|---|---|---|---|
| $D_o$ | mm | | | | | | ±0,50 mm | | |
| $d_{tub}$ | mm | | | | | | ±2,0 % | | |
| $L_{tub}$ | mm | | | | | | ±3,00 mm | | |
| $L_{sh}$ | mm | | | | | | ±3,00 mm | | |
| $W_{rp}$ | mm | | | | | | ±6,00 mm | | |
| $s_{sh}$ | mm | | | | | | ±0,08 mm | | |
| $L_{le}$ | mm | | | | | | ±3,00 mm | | |

**Resistance to pressure**

| **Model** | **Max. operating pressure** bar | **Test pressure** bar | **Requirements satisfactory (Y/N)** |
|---|---|---|---|
| | | | |
| | | | |

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[3] EN 442-2, *Radiators and convectors - Part 2: Test methods and rating*

[4] EN 10219-2, *Cold formed welded structural hollow sections of non-alloy and fine grain steels - Part 2: Tolerances, dimensions and sectional properties*

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