SLOVENSKI STANDARD
SIST EN 1946-3:2000

01-junij-2000

Toplotne značilnosti gradbenih proizvodov in delov stavb - Posebna merila za ocenjevanje laboratorijev, ki merijo lastnosti pri prenosu toplote - 3. del: Meritve z merilniki toplotnega toka

Thermal performance of building products and components - Specific criteria for the assessment of laboratories measuring heat transfer properties - Part 3: Measurements by heat flow meter method

Wärmetechnisches Verhalten von Bauprodukten und Bauteilen - Technische Kriterien zur Begutachtung von Laboratorien bei der Messungen von Wärmeübertragungseigenschaften - Teil 3: Messung nach dem Verfahren mit dem Wärmestrommeßplatten-Gerät

Performance thermique des produits et composants pour le bâtiment - Criteres particuliers pour l'évaluation des laboratoires mesurant les propriétés de transmission thermique - Partie 3: Mesurages selon la méthode fluxmétrique

Ta slovenski standard je istoveten z: **EN 1946-3:1999**

ICS:

91.100.60	Materiali za toplotno in zvočno izolacijo	Thermal and sound insulating materials
91.120.10	Toplotna izolacija stavb	Thermal insulation

SIST EN 1946-3:2000 **en**

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NORME EUROPÉENNE
EUROPÄISCHE NORM

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ICS 91.100.01; 91.120.10

Descriptors: building products, heat transfer, thermal resistance, testing, laboratory assessment, heat flow meter, error analysis, performance check

English version

Thermal performance of building products and components - Specific criteria for the assessment of laboratories measuring heat transfer properties - Part 3: Measurements by heat flow meter method

Performance thermique des produits et composants pour le bâtiment - Critères particuliers pour l'évaluation des laboratoires mesurant les propriétés de transmission thermique - Partie 3: Mesurages selon la méthode fluxmétrique

Wärmetechnisches Verhalten von Bauprodukten und Bauteilen - Technische Kriterien zur Begutachtung von Laboratorien bei der Durchführung der Messungen von Wärmeübertragungseigenschaften - Teil 3: Messung nach dem Verfahren mit dem Wärmestrommeßplatten-Gerät

This European Standard was approved by CEN on 13 December 1998.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 89 "Thermal performance of buildings and building components", the secretariat of which is held by SIS.

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 July 1999, and conflicting national standards shall be withdrawn at the latest by July 1999.

This European Standard is divided into parts. The first part covers common criteria applicable to all heat transfer property measurements; each subsequent part covers the specific technical criteria applicable to each heat transfer property measurement method described in appropriate standards.

The following parts have been developed:

Part 1: Common criteria
Part 2: Measurements by guarded hot plate method
Part 3: Measurements by heat flow meter method
Part 4: Measurements by hot box methods
Part 5: Measurements by pipe test methods

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This part 3 of this standard provides specific technical criteria for the assessment of laboratories to undertake steady-state heat transfer property measurements by the heat flow meter method according to prEN 12667 and prEN 12664.

It complements the common criteria in part 1. Guidance is given on the organization and contents of the equipment manual, the calibration and maintenance files and the measurement procedure document.

It provides information on mandatory equipment performance specifications, equipment description and on calculations for the equipment design and error analysis.

It provides information on experimental procedures suitable for the assessment of equipment accuracy.

2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1946-1:1999	Thermal performance of building products and components - Specific criteria for the assessment of laboratories measuring heat transfer properties - Part 1: Common criteria
prEN 12664:1996	Building materials - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Dry and moist products of medium and low thermal resistance
prEN 12667:1996	Building materials - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Products of high and medium thermal resistance
prEN 12939	Building materials - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Thick products of high and medium thermal resistance
ISO 8301:1991	Thermal insulation - Determination of steady-state thermal resistance and related properties - Heat flow meter apparatus
ISO 8302:1991	Thermal insulation - Determination of steady-state thermal resistance and related properties - Guarded hot plate apparatus

3 Definitions

The definitions in EN 1946-1:1999 and in ISO 8301:1991 also apply to this part of the standard.

4 Equipment manual

4.1 General

The equipment manual shall provide the information specified in 5.2.2 to 5.2.5 of EN 1946-1:1999 and the information specified in this clause.

NOTE: Information common to more than one piece of equipment need not be duplicated, e.g. the principle, details of the design and operation of two pieces of equipment built to a common design.

Annex B of prEN 12664:1996 or prEN 12667:1996, which indicates all limiting values for apparatus performance and testing conditions, shall be used as a check-list during the assessment process by the parties concerned to ensure compliance with all the requirements of those standards.

4.2 Equipment performance specifications

According to 2.3.1 of ISO 8301:1991, the upper and lower limits for the following relevant tested properties and testing conditions, including possible interactions among them, shall be specified:

- specimen thickness;
- thermal resistance;
- temperature difference across the specimen;
- heating and cooling unit temperature;
- surrounding environment (temperature, relative humidity) at the edge of the specimen during the test;
- sensitivity coefficient of the heat flow meter.

4.3 Equipment description

The following information shall be documented and shall be available for examination during the assessment:

- principle of operation (see 1.6 of ISO 8301:1991);
- type of configuration of the apparatus (see 2.1 of ISO 8301:1991);
- principal dimensions of apparatus, in particular heating and cooling unit width, central metering area and guard width;
- simple diagrams illustrating the design of the equipment with special attention to the thermopile design (see 2.2.2.3 of ISO 8301:1991), the heating and cooling unit piping (see 2.2.1.1 of ISO 8301:1991) and edge insulation (see 2.2.5.1 of ISO 8301:1991);
- position, connections and numbering of temperature sensors (see 2.2.3.1 of ISO 8301:1991);
- electrical components/instruments, apparatus enclosure and main ancillary equipment;
- details of data acquisition system and related computer programs for data analysis.

To avoid duplication, reference can be made to manuals supplied by the instrument manufacturers or to relevant clauses of ISO 8301:1991.

4.4 Equipment design and error analysis

4.4.1 General

With reference to the performance specification given in 4.2, details shall be given of the design guidelines followed, and the error analysis as summarized in 4.4.2 to 4.4.9, considering also, when applicable, 2.2 of ISO 8302:1991 on the guarded hot plate apparatus.

Some guidelines on error analysis are given in this subclause; more specific information on some errors is supplied in annex B, while error calculations are supplied in annex C for some typical cases. Examples of equipment conforming to annex C are supplied in D.2 of prEN 12667:1996. For equipment having characteristics exactly as indicated in this subclause or design details as indicated in annex C of this part and in D.2 of prEN 12667:1996, no further calculations are needed. In other circumstances similar calculations can be performed by analogy.

4.4.2 Edge heat losses and maximum specimen thickness

According to 2.2.5.3 of ISO 8301:1991, the edge heat loss error shall be kept within 0,5 %.

For single-specimen asymmetrical configurations, see figure 1a), provided that the heat flow meter thickness is within 2 % of the overall apparatus size, see 1.7.2.2 and 2.2.5.2.1 of ISO 8301:1991 for guidance, the fourth column of table 1 gives for some apparatus dimensions the maximum allowed specimen thickness according to 2.2.1 of ISO 8302:1991 on the guarded hot plate, when there is no edge insulation and when the edge temperature ratio, e, is 0,25; e is defined as $(T_e - T_2)/(T_1 - T_2)$, where T_1 and T_2 are respectively the temperatures of the hot and cold surfaces of the specimen, and T_e is the temperature at the edge of the specimen, assumed to be uniform.

EXAMPLE: $e = 0,25$ corresponds to a temperature of the edge of the specimen 5 K below the mean test temperature, when the temperature difference between the hot and cold side of the specimen is 20 K.

> NOTE: The edge heat loss error is zero for homogeneous isotropic specimens when e is close to 0,5; the absolute value of the edge heat loss error increases almost symmetrically when e deviates on either side from 0,5. In the range $0,25 \leq e \leq 0,75$, this error is maximum for $e = 0,25$.

When the heat flow meter thickness exceeds the above quoted 2 %, the sum of specimen and heat flow meter thickness should conform with table 1 data.

Table 1: Minimum and maximum allowed specimen thickness

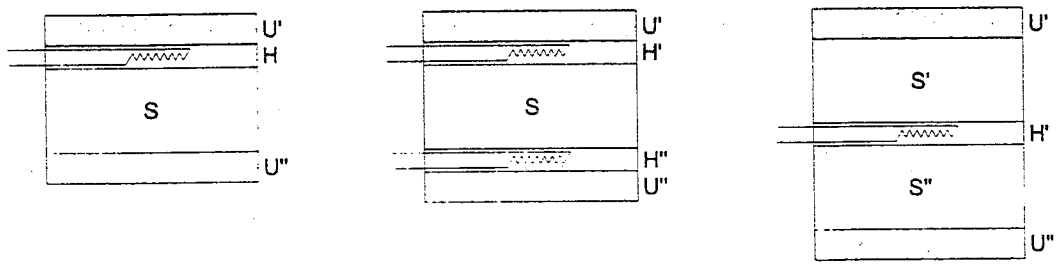
Dimensions in millimetres

Overall size	Metering section	Guard width	Maximum thickness			Flatness tolerance (0,025%)	Minimum thickness (flat. tol.)
			sing. sp. asymmetric for $e = 0,25$	sing. sp. symmetric for $e = 0,25$	two sp. symmetric for $e = 0$		
200	100	50	35	50	30	0,05	10,0
300	200	50	40	60	35	0,08	15,0
300	150	75	50	75	45	0,08	15,0
400	200	100	70	100	60	0,10	20,0
400	100	150	90	130	80	0,10	20,0
500	300	100	75	110	65	0,13	25,0
500	250	125	85	130	75	0,13	25,0
500	200	150	95	140	85	0,13	25,0
600	300	150	100	150	90	0,15	30,0
800	500	150	110	170	100	0,20	40,0
800	400	200	140	210	120	0,20	40,0
1000	500	250	170	260	150	0,25	50,0

For single-specimen symmetrical configurations, see figure 1b), the specimen thickness can be up to 50 % higher than that of the single-specimen asymmetrical configuration, see 1.7.2.2 and 2.2.5.2.3 of ISO 8301:1991 and the fifth column of table 1.

For two-specimen symmetrical configurations, see figure 1c), the specimen thickness shall be smaller than that of the single-specimen asymmetrical configuration, see 2.2.5.2.2 of ISO 8301:1991; calculation can be made for the edge temperature ratio $e = 0$, see the sixth column of table 1.

Larger specimen thicknesses can be used for some specimens if edge insulation or edge temperature control is used, if auxiliary or gradient guards are installed, or medium and high conductivity specimens are tested. See annex B for additional information.



a) **Single-specimen asymmetrical configuration**

b) **Single-specimen symmetrical configuration**

c) **Two-specimen symmetrical configuration**

U', U" cooling and heating units
H, H', H" heat flow meters
S, S', S" specimens

Figure 1: Typical layouts of heat flow meter apparatus configurations

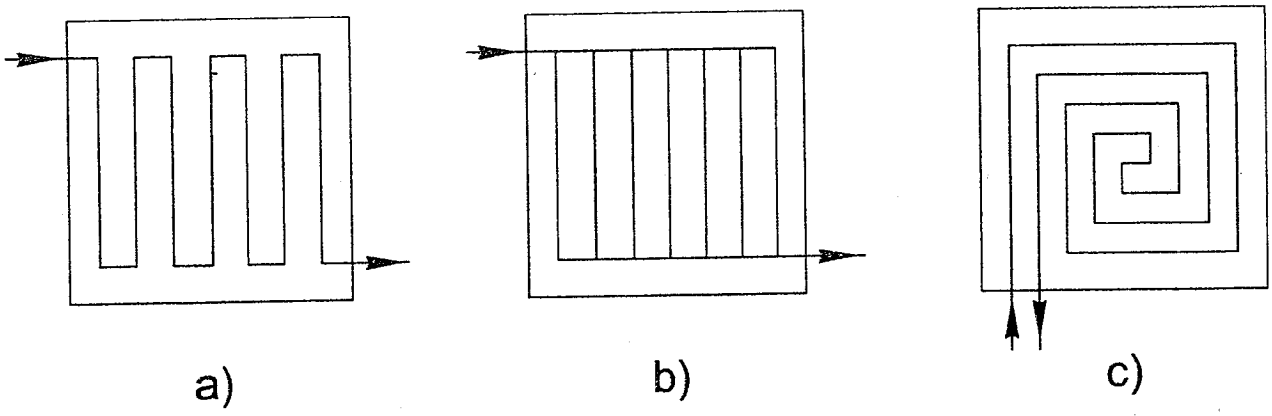


Figure 2: Examples of schematic design of heating or cooling units in the case of external liquid supply

When the maximum specimen thickness to be specified according to 4.2 exceeds the appropriate value given in table 1, lateral losses shall be calculated. If, according to these calculations they exceed those permitted by ISO 8301:1991, the performance check data shall be examined and, if no experimental evidence exists to justify the claimed maximum specimen thickness, the maximum specimen thickness to be specified according to 4.2 shall be reduced.

4.4.3 Minimum specimen thickness

Minimum specimen thickness shall be compatible with flatness tolerance, see 4.4.7 to 4.4.9.

4.4.4 Temperature uniformity of the heating or cooling unit

According to 2.2.1.2 of ISO 8301:1991, the temperature uniformity of the working surfaces of the apparatus shall be better than 1 % of the temperature difference across the specimen. In addition, if a heat flow meter is placed in contact with the working surface of a heating or cooling unit and is sensitive to the temperature variations along this surface, the variations shall be as small as necessary to maintain an error in measured heat flow rate below 0,5 %. The latter requirement cannot be predicted without an accurate knowledge of the thermopile design.

The 1 % temperature uniformity requirement can be checked by considering the largest expected heat flow rate Φ_s through the specimen and the heat flow rate Φ_e towards the environment surrounding the apparatus through the remaining surfaces of the heating or cooling unit. When the heating or cooling unit is kept at its temperature by liquid flow circulation, the temperature difference ΔT_p between the plate inlet and outlet is defined by the following equation where m_r is the mass flow rate and c is the specific heat of the liquid circulated:

$$\Phi_s + \Phi_e = m_r \, c \, \Delta T_p$$

The value of ΔT_p can be assumed as temperature non-uniformity for most liquid-paths (see figure 2a) and 2b)). For helical counter flow paths (see figure 2c)) the temperature uniformity can in some cases be better, but calculations are more complex (see 2.2.1.1 of ISO 8301:1991).

4.4.5 Error in the temperature difference between the heating and cooling units of the apparatus

According to 2.2.3.1.1 of ISO 8301:1991, the total error in the temperature difference measured by the temperature sensors permanently mounted in the apparatus shall not exceed 1 %, made up of the terms a) and b) as follows:

a)
- calibration of thermocouples (or other temperature sensors): less than 0,4 %;
- linearity of measuring instruments: less than 0,1 %;
- stability of measuring instruments: less than 0,2 %;
- noise immunity of measuring instruments: less than 0,1 %;

these four terms added quadratically give a total uncertainty of 0,5 %;

b)
- uncertainty in the definition of the point where the temperature is measured by the sensor: less than 0,5 %.

NOTE 1: When special grade thermocouples (see annex D of ISO 8301:1991) mounted differentially are used, as in figure 6 b) or 6 c) of ISO 8302:1991 (on the guarded hot plate), and no additional wire connections between the junctions are made, no calibration is required, and the uncertainty of 0,4 % at room temperature can be achieved for type T thermocouples.

NOTE 2: The absence of additional wire connections between two thermocouple junctions and the care taken to correctly fabricate these junctions and to keep them as isothermal as possible during the tests, are more important than the thermocouple calibration itself. Bad thermocouple connections can induce errors which change with changing test conditions, so derating the accuracy of the calibrations.

NOTE 3: The uncertainty in the definition of the point where the temperature is measured can be assumed to cause an error in the temperature reading not greater than the temperature drop through the metal plates when thermocouples are mounted in grooves in the apparatus metal plates. When thermocouples are mounted in thin sheets, the uncertainty becomes critical and can be assumed to be equal to the temperature drop through a layer of sheet of thickness equal to the diameter of the thermocouple junction.

NOTE 4: Additional errors occur due to contact thermal resistances or due to mounting techniques of the thermocouples on specimen surfaces, see 4.4.8 and 4.4.9.

4.4.6 Error in the measurement of the specimen thickness

The error of the measuring devices, shall not exceed 0,5 %, see 2.2.3.3 of ISO 8301:1991, and the additional error resulting from the departures from a true plane of the apparatus and specimen surfaces shall not exceed 0,5 %, see A.3.3 of prEN 12667:1996 or prEN 12664:1996.

4.4.7 Non rigid specimens: error in specimen thickness and minimum specimen thickness

This error in specimen thickness applies only when testing non-rigid specimens in good contact with the heat flow meter apparatus and whose thermal resistance is 0,3 $m^2 \cdot K/W$ or more, e.g. mineral wool boards or elastomeric cellular boards. This error is the consequence of departures