

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS A 4710 : 2015

(JTCCM/JSA)

**Windows and doorsets—Thermal
resistance test**

ICS 91.060.50;91.120.10

Reference number : **JIS A 4710 : 2015 (E)**

 **Documents**
Document Sharing Hub

PROTECTED BY COPYRIGHT

36 S

Date of Establishment: 1979-02-01

Date of Revision: 2015-03-20

Date of Public Notice in Official Gazette: 2015-03-20

Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area
Technical Committee on Architecture

JIS A 4710:2015, First English edition published in 2016-06

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2016

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED BY COPYRIGHT

Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Terms, definitions, symbols and units	2
3.1 Terms and definitions	2
3.2 Symbols and units	2
4 Principle	5
5 Requirements for apparatus and test specimens	7
5.1 General	7
5.2 Surround panels	8
5.3 Calibration panels	8
5.4 Temperature measurements and baffle positions	9
5.5 Air flow measurement	9
5.6 Test specimens	10
6 Test procedure	11
6.1 General	11
6.2 Calibration measurements	11
6.3 Measurement procedure for test specimens	14
6.4 Expression of results for standardized test applications	15
7 Test report	15
Annex A (normative) Environmental temperatures	17
Annex B (normative) Linear thermal transmittance of the edge zone	21
Annex C (informative) Calibration panels	32
Annex D (informative) Example of calibration test and measurement of window specimen	35
Annex E (informative) Uncertainty analysis for measurement of thermal transmittance using hot box	41
Annex JA (normative) Test specimen mounting and heat transfer aperture dimensions	49
Annex JB (normative) Direction of airflow from throttling device	55
Annex JC (informative) Measurement of heat loss from surround panel	56

Annex JD (informative)	Comparison table between JIS and corresponding International Standard	58
Annex JE (informative)	Comparison table between previous and current editions of this Standard on technically significant revisions	63

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Testing Center for Construction Materials (JTCCM)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS A 4710:2004** is replaced with this Standard.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

Windows and doorsets—Thermal resistance test

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **ISO 12567-1** published in 2010 with some modifications of the technical contents so that it can be used in Japan.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JD. The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex JE.

1 Scope

This Standard specifies the test method for the thermal resistance of windows and doorsets.

This Standard, however, does not apply to the following:

- a) edge effects occurring outside the perimeter of the specimen;
- b) energy transfer due to solar radiation on the specimen;
- c) effects of air leakage through the specimen;
- d) roof windows and projecting windows.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 12567-1:2010 *Thermal performance of windows and doors—Determination of thermal transmittance by the hot-box method—Part 1: Complete windows and doors* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent edition of the standards (including amendments) indicated below shall be applied.

JIS A 0202 *Thermal insulation—Vocabulary*

NOTE : Corresponding International Standards: ISO 7345 *Thermal insulation—Physical quantities and definitions*, ISO 9288 *Thermal insulation—Heat transfer by radiation—Physical quantities and definitions* (MOD)

JIS A 1412-1 *Test method for thermal resistance and related properties of thermal insulations—Part 1: Guarded hot plate apparatus*

NOTE : Corresponding International Standard: ISO 8302 *Thermal insulation—Determination of steady-state thermal resistance and related properties—Guarded hot plate apparatus* (MOD)

JIS A 1412-2 *Test method for thermal resistance and related properties of thermal insulations—Part 2: Heat flow meter apparatus*

NOTE : Corresponding International Standard: ISO 8301 *Thermal insulation—Determination of steady-state thermal resistance and related properties—Heat flow meter apparatus* (MOD)

JIS A 1420 *Determination of steady-state thermal transmission properties—Hot box method*

NOTE : Corresponding International Standard: ISO 8990 *Thermal insulation—Determination of steady-state thermal transmission properties—Calibrated and guarded hot box* (MOD)

JIS C 1602 *Thermocouples*

NOTE : Corresponding International Standard: IEC 60584-1 *Thermocouples—Part 1: EMF specifications and tolerances* (MOD)

JIS R 3106 *Testing method on transmittance, reflectance and emittance of flat glasses and evaluation of solar heat gain coefficient*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS A 0202**, and the following apply.

3.1.1 heat transfer aperture dimensions

width and height dimensions excluding protruding sections e.g. a fin for mounting fittings to the building frame, a rail receptacle

In this Standard, it refers to heat transfer dimension of test specimen.

3.1.2 heat transfer area

product of width and height dimensions of heat transfer aperture

NOTE : Annex JA specifies the method to measure heat transfer aperture dimensions.

3.2 Symbols and units

Symbols and units shall be in accordance with **JIS A 0202**, and Tables 1 to 3.

Table 1 Symbols and units

Symbol	Physical quantity	Unit
A	Heat transfer area	m^2
d	Thickness (depth)	m
F	Convective fraction	—
f	View factor	—
h	Surface coefficient of heat transfer	$\text{W}/(\text{m}^2 \cdot \text{K})$
H	Height	m
L	Perimeter length	m
q	Density of heat flow rate	W/m^2
R	Thermal resistance or surface thermal resistance	$\text{m}^2 \cdot \text{K}/\text{W}$
T	Thermodynamic temperature	K
U	Thermal transmittance	$\text{W}/(\text{m}^2 \cdot \text{K})$
w	Width	m
α	Radiant factor	—
$\Delta T, \Delta \theta$	Temperature difference	K
ε	Total hemispherical emissivity	—
θ	Celsius temperature	$^{\circ}\text{C}$
λ	Thermal conductivity	$\text{W}/(\text{m} \cdot \text{K})$
σ	Stefan-Boltzmann constant 5.67×10^{-8}	$\text{W}/(\text{m}^2 \cdot \text{K}^4)$
Φ	Heat flow rate	W
Ψ	Linear thermal transmittance	$\text{W}/(\text{m} \cdot \text{K})$

Table 2 Subscripts

Subscript	Significance
b	Baffle
c	Convection (air)
cal	Calibration
e	External, usually cold side
edge	Edge
i	Internal, usually warm side
in	Input
j	Layer
l	Hot box
m	Measured
me	Mean
n	Environmental (ambient)
ne	Environmental (ambient) external
ni	Environmental (ambient) internal
p	Reveal of surround panel
r	Radiation (mean)
s	Surface
sp	Specimen
st	Standardized
sur	Surround panel
t	Total

Table 3 Symbols and units for uncertainty analysis for thermal transmittance using hot boxes

Symbol	Physical quantity	Unit
A_{sp}	Test specimen heat transfer area	m^2
A_{sur}	Surround panel heat transfer area	m^2
λ_{sur}	Surround panel thermal conductivity	$W/(m \cdot K)$
d_{sur}	Surround panel thickness (depth)	m
Φ_l	Heat loss from the hot box	W
Φ_{edge}	Edge heat loss	W
Φ_{in}	Heat input to the hot box	W
Φ_{sp}	Heat transfer through the test specimen	W
Φ_{sur}	Heat transfer through the surround panel	W
θ_n	Hot-box ambient air temperature	$^{\circ}C$
θ_c	Cold side (climatic chamber) external air temperature	$^{\circ}C$
θ_i	Warm side (metering room) internal air temperature	$^{\circ}C$
U_{cal}	Thermal transmittance of calibration panel	$W/(m^2 \cdot K)$
U_m	(Measured) thermal transmittance of the test specimen	$W/(m^2 \cdot K)$
U_{st}	Thermal transmittance of the standardized test specimen	$W/(m^2 \cdot K)$
σ	Stefan-Boltzmann constant 5.67×10^{-8}	$W/(m^2 \cdot K^4)$
$\Delta\theta$	Temperature difference	K
∂	Partial derivative	
$\Delta\theta_{sur}$	Surround panel surface temperature difference	K
The uncertainty analysis using hot boxes is as given in Annex E.		

4 Principle

The thermal transmittance, U , of the specimen is measured by means of the calibrated hot-box method (CHB method) or guarded hot-box method (GHB method) in accordance with **JIS A 1420**.

NOTE : In this Standard, it refers to principles for calibrated hot-box method (CHB method).

The determination of the thermal transmittance involves two stages. Firstly, measurements are made on two calibration panels with accurately known thermal properties, from which the surface coefficient of the heat transfer (radiative and convective components) on both sides of the calibration panel with surface emissivities on average similar to those of the specimen to be tested and the thermal resistance of the surround panel are determined. Secondly, measurements are made with the window or door specimens in the aperture and the hot-box apparatus is used with the same fan settings on the warm and cold sides as during the calibration procedure.

The major heat flows in CHB method shall be as shown in Figure 1. The thermal transmittance shall be obtained by Equation (1), measuring air temperatures at both

sides of the specimen, surface temperature on baffle, etc., and determining the environmental temperature as specified in Annex A.

$$U = \frac{\phi_{in} - \phi_l - \phi_{sur} - \phi_{edge}}{\Delta \theta_n \cdot A} \quad (1)$$

The heat loss from the hot box, ϕ_l , shall be calculated in accordance with **JIS A 1420**.

The surround panel is used to keep the specimen in a given position. It is constructed with outer dimensions of appropriate size for the apparatus, having an aperture to accommodate the specimen (see Figure 2). The boundary edge heat flow, ϕ_{edge} , due to the location of the calibration panel in the surround panel is determined separately by a linear thermal transmittance, Ψ . The magnitude of the boundary edge heat flow is determined by tabulated values given in Annex B using the linear thermal transmittance, Ψ , as a function of geometry, calibration panel thickness and thermal conductivity. Measurement results are corrected to standardized surface heat transfer coefficient from the coefficient at the time of testing.

Measurements are taken (e.g. pressure equalization between the warm and cold side or sealing of the joints on the inside) to ensure that the air permeability of the test specimen does not influence the measurements.

NOTE : The surround panel may be calibrated including the boundary edge heat flow.

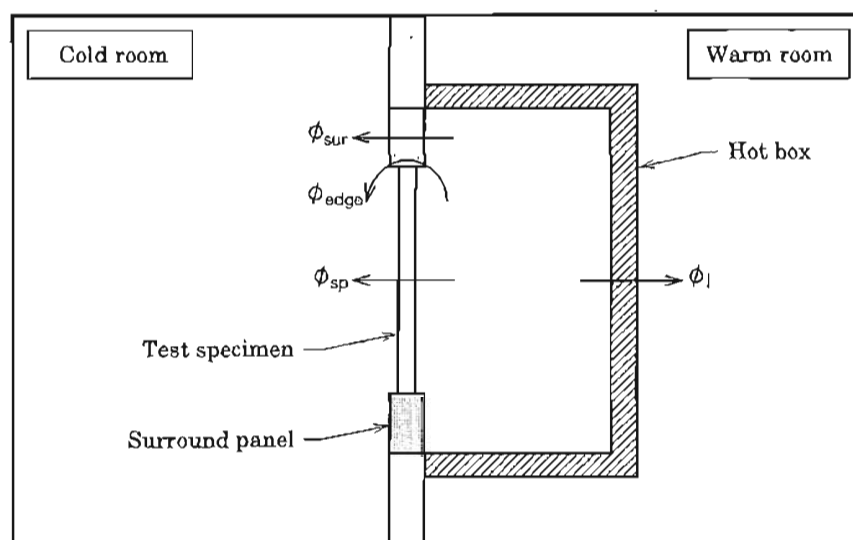


Figure 1 Principle

Unit: mm

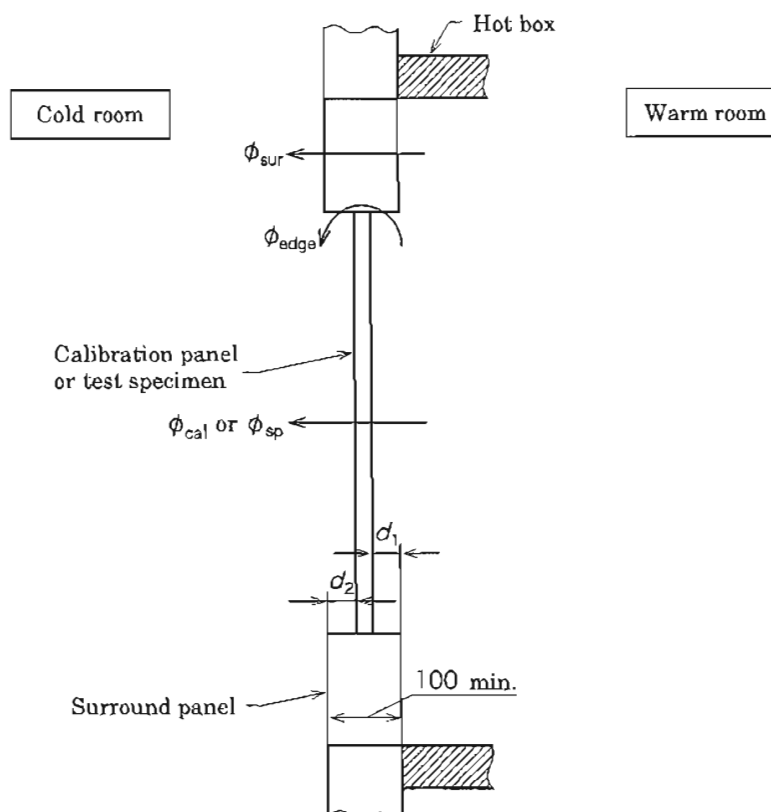


Figure 2 Location of calibration panel or test specimen and the surround panel

5 Requirements for apparatus and test specimens

5.1 General

The construction of test apparatus shall be as shown in Figure 3. The construction and operation of the apparatus shall comply with the requirements specified in **JIS A 1420**, unless otherwise specified in this Standard.

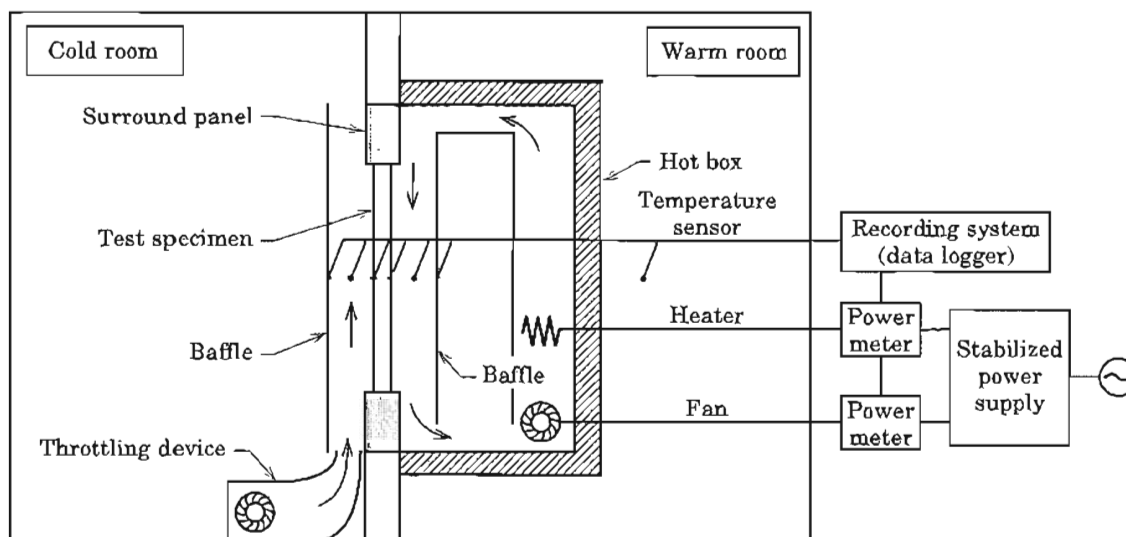


Figure 3 Test apparatus for calibrated hot-box method (cross-section)

5.2 Surround panels

The surround panel acts as an idealized wall with high thermal resistance and holds the window or door in the correct position and separates the warm box from the cold box. The surround panel shall be of the same size as the open face of the hot box, and be not less than 100 mm thick or the maximum thickness of the specimen, whichever is the greater, and it shall be constructed with core material of stable thermal conductivity not greater than $0.04 \text{ W/(m} \cdot \text{K)}$. Sealed plywood facing or plastic sheet on either side of the surround panel to provide rigidity is permitted. An appropriate aperture shall be provided to accommodate the calibration panel or test specimen (see Figure 2). No material of thermal conductivity higher than $0.04 \text{ W/(m} \cdot \text{K)}$ (other than non-metallic thin tape) shall bridge the aperture. The aperture to insert the test specimen shall be at the centre of the surround panel. The surfaces of the surround panel and baffle plates shall have a high emissivity (0.8 or over).

5.3 Calibration panels

Calibration panels shall be of a size similar to the test specimen. They are required to set up specified test conditions, to determine the surface coefficients of heat transfer and to establish the thermal resistance of the surround panel.

Calibration panels shall satisfy the following requirements.

- The calibration panel or its core material shall be made of homogeneous material with known thermal conductivity or thermal resistance. The material used shall not be prone to ageing effects.
- The nature of the surface of the calibration panel shall be similar to that of the test specimen. The emissivity of the surface shall be known (e.g. normal float glass) or shall be measured in accordance with **JIS R 3106**.
- The calibration panels shall cover the range of test specimen density of heat flow rate under the conditions of calibration. Two calibration panels with different thermal resistance shall be used to prepare for specimens of various thermal insulations.

This however does not apply to single calibration panel covering the density of heat flow rate of the specimen.

The standard dimensions of calibration panel shall be 1 600 mm × 1 600 mm.

The thermal resistance of calibration panels, or thermal resistance/thermal conductivity of the insulating material used in the panels shall be measured for mean temperatures in the range 0 °C to 15 °C, using a guarded hot plate or heat flow meter apparatus in accordance with **JIS A 1412-1** or **JIS A 1412-2**, respectively.

Alternatively, calibration panels may be used with certified properties from an accredited source.

In any case, the calibration panel shall be mounted in the surround panel aperture at the position where a specimen is mounted in the warm side (dimension d_1 in Figure 2).

NOTE : Types of calibration panels are shown in Annex C.

5.4 Temperature measurements and baffle positions

For calibration measurements, the warm and cold side surface temperatures shall be measured or calculated. A minimum of nine positions at the centre of a rectangular grid of equal areas shall be used on the calibration panel, eight positions on the surround panel, and a minimum of one position at the centre of each side of the reveal of surround panel (Figure 4). No temperature sensors shall be closer than 100 mm to the edge of the calibration panel. It is recommended that the same layout of the surface temperature grid on the calibration panel be used (a minimum of nine) for air temperature and baffle plate measurements.

- a) **Temperature sensor** The recommended temperature sensor to be used for surface temperature measurement is the type T thermocouple in accordance with **JIS C 1602** made from wire with diameter not greater than 0.2 mm. Temperature sensors and recording systems shall be regularly calibrated. They shall be fixed to the surface using adhesive or adhesive tape with an outer surface of high emissivity (0.8 or over).
- b) **Baffle positions** For the warm side, air speed representing natural convection, and a fan for agitation shall be used. The distance between the baffle and the plane of the warm face of the surround panel shall be not less than 150 mm and on the cold face not less than 100 mm for appropriate air speed. Air temperatures shall be measured on each side outside the boundary layer.

If this method is impracticable, Annex JB may be applied.

5.5 Air flow measurement

The cold side air speed shall be measured at a position that represents the free stream condition.

For either vertical or horizontal flow patterns, it is essential that the sensor not be in the test specimen surface boundary layers or in the wake of any projecting fitting.

Unit: mm

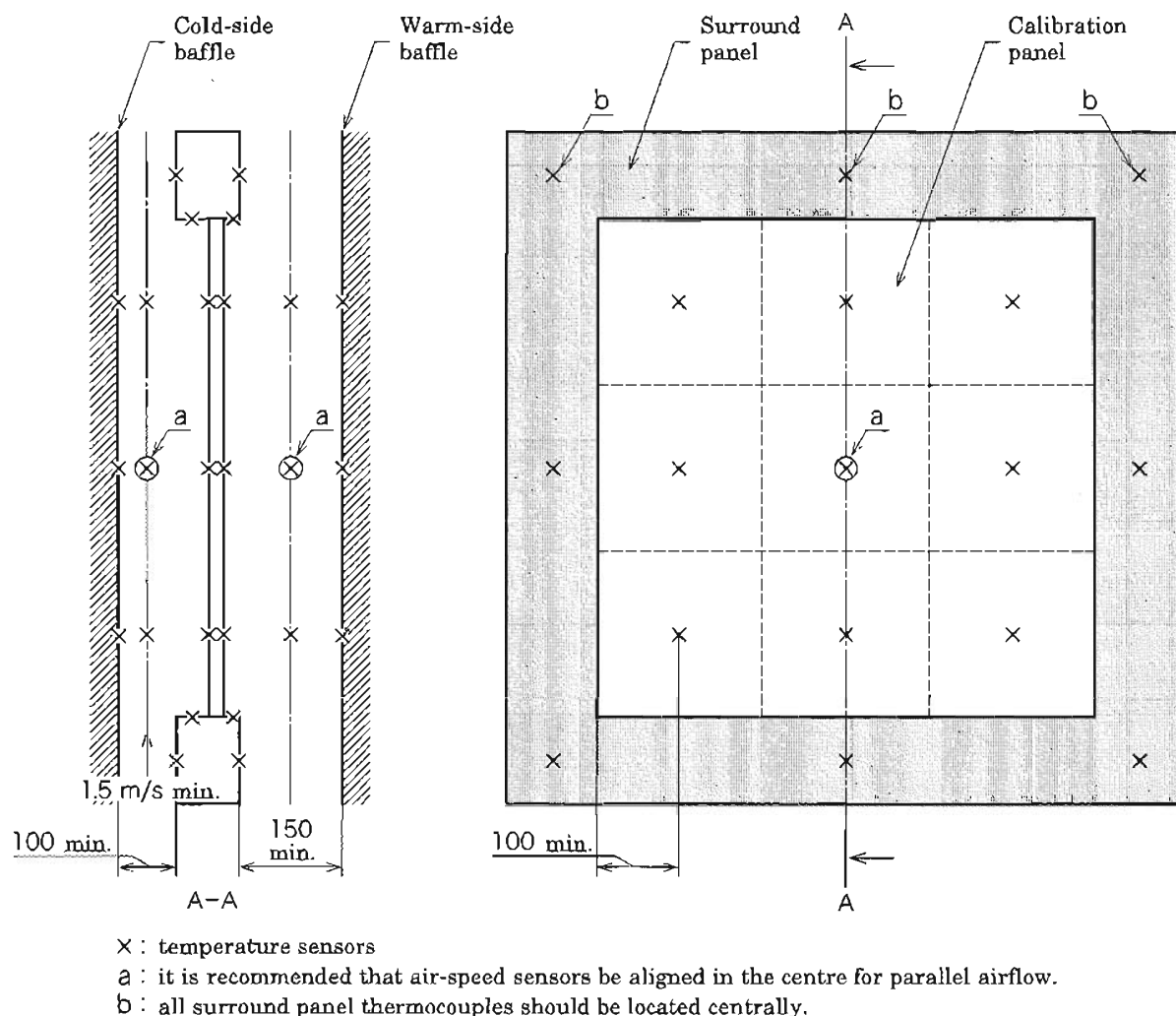


Figure 4 Location of temperature and air speed sensors

5.6 Test specimens

Test specimens shall fit the surround panel aperture. The standard dimensions of the test specimen in the case of using the calibration panel shall be as follows.

- Window and double-sliding sash**, about 1 700 mm in width × 1 800 mm in height, or about 1 700 mm in width × 1 300 mm in height
- Door**, about 900 mm in width × 1 900 mm in height

The gap between the surround panel and the test specimen shall be no more than 5 mm. The perimeter joints between the surround panel and the specimen shall be sealed on both sides with tape, caulking or mastic material. Test specimen mounting and heat transfer aperture dimensions shall be as given in Annex JA.

The heat transfer aperture area of the test specimen shall be 0.8 m² or more. When windows or doorsets which do not comply with the specified heat transfer aperture area are used as test specimens, several test specimens of the same dimensions shall be aligned and measured with their total heat transfer aperture area 0.8 m² or more. In this case, individual test specimens shall have a heat transfer area 0.2 m² or more. The

specimens shall be aligned horizontally. If this is impracticable, the specimens may be aligned vertically. The width of the surround panel to be placed between test specimens shall be 150 mm or more.

6 Test procedure

6.1 General

The major procedure for measurement using hot box shall be as specified in JIS A 1420, 6.2 to 6.4.

Examples of calibration test and measurement of window specimen are given in Annex D. Measurement of heat loss from the surround panel is given in Annex JC.

6.2 Calibration measurements

6.2.1 General

Additional calibration tests are required to ensure that suitable test conditions are set up and that the surround panel heat flow and surface heat transfer coefficients can be fully accounted for. It is recommended to make the calibration measurements at a minimum of three different mean air temperatures $\theta_{c,me}$ [$\theta_{c,me} = (\theta_{c,i} + \theta_{c,e})/2$] in steps of ± 5 K by varying the cold side air temperature, retaining constant conditions of air movement on the cold side and constant air temperature and natural convection on the warm side. Using this procedure, surface resistances and coefficients of heat transfer can be determined as a function of the total density of heat flow rate through the calibration panel.

NOTE : It is considered that for non-homogeneous test specimens, such as windows or doors, the mean heat transfer conditions over the measured area are comparable to those of the given calibration panel. Depending on the range of density of heat flow rate, the surface thermal resistance may be regarded as constant value.

6.2.2 Total surface thermal resistance

6.2.2.1 Measurement

The calibration test shall be made with the calibration panel at a mean temperature of approximately 10 °C and a temperature difference between warm and cold sides of (20 ± 2) K (see Annex A). The air velocity on the cold side shall be adjusted for the first calibration test by throttling or by fan speed adjustment to give a total surface thermal resistance (warm and cold side) $R_{s,t} = 0.17 \pm 0.01$ (m² · K/W). In this case, the air velocity on the cold side shall be 1.5 m/s or more. Thereafter, the fan speed settings or the throttling devices shall remain constant for all subsequent calibration measurements. The air velocity setup used for the calibration procedure shall be used for all tests with specimens of windows or doors.

6.2.2.2 Calculation

Calculate the total surface thermal resistance of the both sides, $R_{s,t}$ (m² · K/W), using Equation (2):

$$R_{s,t} = \frac{\Delta\theta_{n,cal} - \Delta\theta_{s,cal}}{q_{cal}} \quad (2)$$

where, $\Delta\theta_{n,cal}$: difference between environmental temperatures on each side of the calibration panel, in kelvin, calculated according to Annex A;

$\Delta\theta_{s,cal}$: surface temperature difference of the calibration panel, in kelvin;

q_{cal} : density of heat flow rate of the calibration panel, in watts per square metre, determined from the known thermal resistance, R_{cal} , of the calibration panel (at the mean temperature, q_{cal}) and the surface temperature difference, $\Delta\theta_{s,cal}$, calculated using Equation (2):

q_{cal} shall be calculated using Equation (3):

$$q_{cal} = \frac{\Delta\theta_{s,cal}}{R_{cal}} \dots\dots\dots (3)$$

where, R_{cal} : thermal resistance ($m^2 \cdot K/W$) at a mean temperature of the calibration panel [see Equation (4)]

$$R_{cal} = \sum \frac{d_j}{\lambda_j} \dots\dots\dots (4)$$

where, d_j : thickness (m)

λ_j : thermal conductivity [$W/(m \cdot K)$]

NOTE : The total surface thermal resistance, $R_{s,t}$, shall be plotted as a function of the density of heat flow rate, q_{cal} , of the calibration panel.

6.2.3 Surface resistances and surface coefficients of heat transfer

6.2.3.1 General

Surface coefficients of heat transfer (convective and radiative parts) are required in order to determine the environmental temperatures (in accordance with the procedures given in Annex A).

The warm and cold side surface resistances shall be calculated using Equations (5) and (6):

$$R_{si} = \frac{\theta_{ni,cal} - \theta_{si,cal}}{q_{cal}} \dots\dots\dots (5)$$

$$R_{sc} = \frac{\theta_{sc,cal} - \theta_{nc,cal}}{q_{cal}} \dots\dots\dots (6)$$

where, q_{cal} : density of heat flow rate through the calibration panel, in W/m^2 ;

$\theta_{ni,cal}$: environmental temperature on the warm side, in degrees Celsius

$\theta_{si,cal}$: warm side surface temperature of the calibration panel, in degrees Celsius

$\theta_{se,cal}$: cold side surface temperature of the calibration panel, in degrees Celsius

$\theta_{ne,cal}$: environmental temperature on the cold side, in degrees Celsius

6.2.3.2 Convective fraction

Evaluate the radiative and convective parts of the surface coefficients of heat transfer from the calibration data for the warm and cold sides in accordance with the procedure given in Annex A and determine the convective fraction, F_c , using Equation (7):

$$F_c = \frac{h_c}{h_c + h_r} \dots\dots\dots (7)$$

where, h_c : convective coefficient of heat transfer, in $W/(m^2 \cdot K)$

h_r : radiative coefficient of heat transfer, in $W/(m^2 \cdot K)$

The variation of the convective fraction, F_c , shall be plotted for both sides as a function of q_{cal} (density of heat flow rate of the calibration panel).

The environmental temperature, θ_n , at the measurement of the test specimen shall be calculated using Equation (8) by performing the interpolation of, F_c , at the calibration.

$$\theta_n = F_c \cdot \theta_c + (1 - F_c) \cdot \theta_r \dots\dots\dots (8)$$

6.2.4 Surround panel and edge corrections

The heat flow rate through the surround panel shall be obtained by subtracting the heat loss from the hot box, the heat flow rate through the surround panel and the edge heat loss, from the heat input to the hot box (Figure 5). The thermal resistance, R_{sur} , shall be calculated from the temperature difference between both surfaces of the panel, $\Delta\theta_{s,sur}$, and the area, A_{sur} , using Equation (9). Plot thermal resistance as a function of the mean temperature.

For heat loss from the edge zone, Φ_{edge} , use the linear thermal transmittance, which is obtained from the thickness of the calibration panel, mounting position, etc. in accordance with Annex B.

$$R_{sur} = \frac{A_{sur} \cdot \Delta\theta_{s,sur}}{\Phi_{in} - \Phi_l - \Phi_{cal} - \Phi_{edge}} \dots\dots\dots (9)$$

where, A_{sur} : heat transfer area of the surround panel, in square metres

$\Delta\theta_{s,sur}$: difference between the surface temperatures of the surround panel, in kelvin

Φ_{in} : heat generated in hot box, in watts

Φ_l : heat loss of hot box, in watts

Φ_{cal} : heat flow rate through the calibration panel, in watts [see Equation (10)]

$$\Phi_{cal} = A_{cal} \cdot q_{cal} \dots\dots\dots (10)$$

Φ_{edge} is the heat flow rate, in watts, passing between the calibration panel and the surround panel, to be determined by Equation (11).

$$\Phi_{\text{edge}} = L_{\text{edge}} \cdot \Psi_{\text{edge}} \cdot \Delta\theta_c \dots\dots\dots (11)$$

where, L_{edge} : perimeter length between surround panel and calibration panel, in metres
 Ψ_{edge} : linear thermal transmittance between surround panel and calibration panel, in W/(m · K)
 $\Delta\theta_c$: difference between the warm and the cold side air temperatures, in kelvin

This calibration procedure allows the results from a given size of calibration panel to be applied to a different size of test specimen.

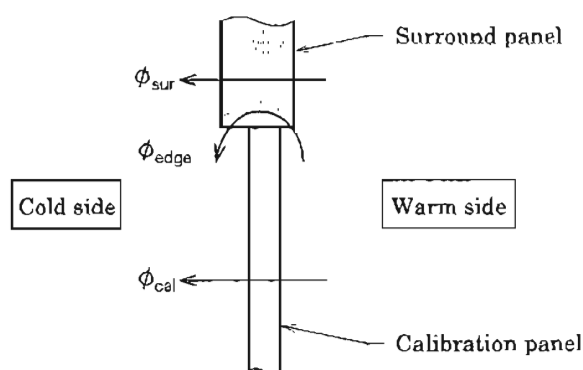


Figure 5 Heat flow rate through calibration panel and heat loss from edge zone

The thermal resistance, R_{sur} , of surround panel can be obtained by determining the thermal conductivity of the thermal insulation material to be used for the panel as specified in JIS A 1412-1 or JIS A 1412-2, then by Equation (12).

$$R_{\text{sur}} = \frac{d_{\text{sur}}}{\lambda_{\text{sur}}} \dots\dots\dots (12)$$

6.3 Measurement procedure for test specimens

The measurement of the test specimens shall be made under the same conditions as for the corresponding calibrations as described in 6.2.2, at a mean air temperature of approximately 10 °C and an air temperature difference of $\Delta\theta_c \approx (20 \pm 2)$ K.

The relative humidity in the hot box shall be kept at low enough levels to avoid condensation.

The density of heat flow rate, q_{sp} , through the test specimen shall be calculated using Equation (13):

$$q_{\text{sp}} = \frac{\Phi_{\text{in}} - \Phi_l - \Phi_{\text{sur}} - \Phi_{\text{edge}}}{A_{\text{sp}}} \dots\dots\dots (13)$$

where, Φ_{sur} : heat flow rate through the surround panel in watts, given by Equation (14):

$$\Phi_{\text{sur}} = \frac{A_{\text{sur}} \cdot \Delta\theta_{\text{s,sur}}}{R_{\text{sur}}} \dots\dots\dots (14)$$

where, Φ_{edge} : edge zone heat flow rate according to Equation (11),
in watts

A_{sp} : heat transfer area of the test specimen, in square
metres

R_{sur} : thermal resistance of the surround panel, in
 $\text{m}^2 \cdot \text{K/W}$

The thermal transmittance, U_{m} , of the test specimen shall be calculated using Equation (15):

$$U_{\text{m}} = \frac{q_{\text{sp}}}{\Delta\theta_{\text{n}}} \dots\dots\dots (15)$$

where $\Delta\theta_{\text{n}}$ is the difference between the environmental temperatures on each side of the system under test, in Kelvin [see Equation (8), where F_{ci} , F_{ce} are determined by calibration].

The temperature and heat flow rate shall be measured three times at an interval of 30 min after they reach steady state.

Steady state refers to the condition in which the air temperature difference between the warm side and cold side and the values of heat both measured at an interval of 30 min vary by no more than 1 %, free from unilateral fluctuation.

6.4 Expression of results for standardized test applications

The thermal transmittance, U_{st} , obtained by converting the surface resistance to the standard value (hereafter referred to as standardized thermal transmittance) shall be calculated from the measured thermal transmittance, U_{m} , of the test specimen using the standard total surface thermal resistance, $R_{(\text{s,t}),\text{st}}$, by Equation (16). $R_{(\text{s,t}),\text{st}}$ shall be $0.17 \text{ m}^2 \cdot \text{K/W}$.

$$U_{\text{st}} = [U_{\text{m}}^{-1} - R_{\text{s,t}} + R_{(\text{s,t}),\text{st}}]^{-1} \dots\dots\dots (16)$$

NOTE : The total surface thermal resistance, R_{st} , shall be evaluated from the calibration data as a function of the density of heat flow rate, q , derived by interpolation or by an analytical iteration procedure.

7 Test report

The test report shall contain the following information.

a) All details necessary to identify the product tested such as:

- width, height, thickness, sketches showing the structure of the specimen and the cross-section of the specimen, materials, type of glass, etc.;
- application of air tightening, e.g. sealing.

b) Method of calibration,

e.g. calibration curves, analytical calibration functions.

c) **The results of the following measurements:**

- calibrated heat flow rate of calibrated hot box;
- environmental temperature on the warm side, θ_{ni} , in kelvin;
- environmental temperature on the cold side, θ_{nc} , in kelvin;
- the measured thermal transmittance, U_m of the test specimen, in $W/(m^2 \cdot K)$;
- standardized thermal transmittance, U_{st} , in $W/(m^2 \cdot K)$.

d) **Test period and test location**

Annex A (normative)

Environmental temperatures

A.1 General

In this Annex, the notations shown in Figure A.1 are used.

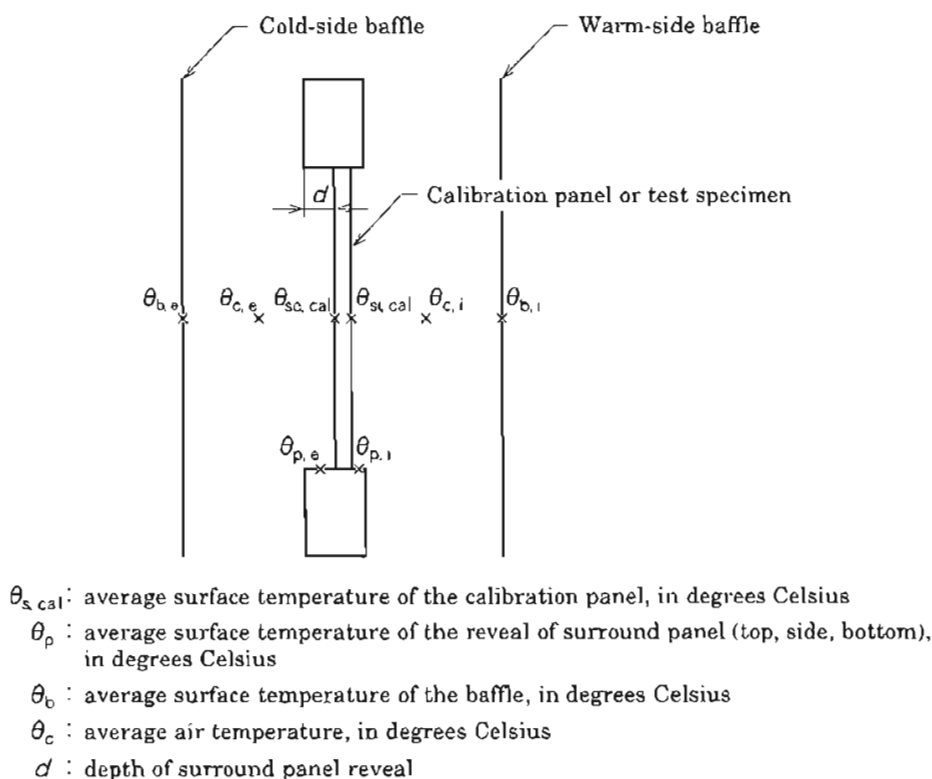


Figure A.1 Notations used for the environmental temperature

A.2 Environmental temperature

The environmental temperature, θ_n , in degrees Celsius, is the weighting of the radiant temperature, θ_r , and the air temperature, θ_c , to be calculated using Equation (A.1): The convective fraction, F_c , as explained in 6.2.3.2, shall be calculated from the calibration measurements as a function of the density of heat flow rate, q_{cal} .

$$\theta_n = \frac{h_c \cdot \theta_c + h_r \cdot \theta_r}{h_c + h_r} \quad \text{..... (A.1)}$$

where, h : surface coefficients of heat transfer, in $W/(m^2 \cdot K)$;
 c : index referring to mean air temperature
 r : index referring to mean radiant temperature

A.3 Mean radiant temperature

The mean radiant temperature, θ_r , in degrees Celsius, of the surfaces “seen” by the surface of the test specimen or the calibration panel shall be calculated using Equations (A.2), (A.3) or (A.4):