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**Thermal performance of windows and
doors — Determination of solar heat gain
coefficient using solar simulator**

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Foreword

This Japanese Industrial Standard has been 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 Construction Material & Housing Equipment Industries Federation (J-CHIF)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS A 1493:2014**), which has been technically revised.

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Thermal performance of windows and doors — Determination of solar heat gain coefficient using solar simulator

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 19467** : 2017, Edition 1, with some modifications of the technical content to reflect the conditions unique to Japan.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA. The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex JB. Annex JB is unique to **JIS** and not given in the corresponding International Standard.

1 Scope

This Standard specifies a method to measure the solar heat gain coefficient of complete windows and doors using a solar simulator.

This Standard applies to windows and doors

- a) with various types of glazing (glass or plastic; single or multiple glazing; with or without low emissivity coatings, with or without paper sliding sashes, and with spaces filled with air or other gases),
- b) with opaque panels,
- c) with various types of frames (wood, plastic, metallic with and without thermal barrier or any combination of materials)
- d) with various types of shading devices (blind, screen, paper sliding sash or any attachment with shading effects)
- e) with various types of active solar fenestration systems [building-integrated PV systems (BIPV) or building-integrated solar thermal collectors (BIST)].

This Standard does not include the following :

- f) shading effects of building elements (e.g. eaves, sleeve wall, etc.);
- g) heat transfer caused by air leakage between indoors and outdoors;
- h) ventilation of air spaces in double and coupled windows;
- i) thermal bridge effects at the rebate or joint between the window or door frame and the rest of the building envelope.

This Standard does not apply to the following :

- j) bay windows;
- k) curtain walls;
- l) industrial, commercial and garage doors.

NOTE 1 Solar simulators are specified in **JIS C 8904-9**.

NOTE 2 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 19467 : 2017 *Thermal performance of windows and doors — Determination of solar heat gain coefficient using solar simulator* (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

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS A 0202 *Thermal insulation — Vocabulary*

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

JIS A 2103 *Thermal performance of windows and doors — Calculation of solar heat gain coefficient*

JIS A 4710 *Windows and doorsets — Thermal resistance test*

NOTE Normative reference in the corresponding International Standard : ISO 12567-1 *Thermal performance of windows and doors — Determination of thermal transmittance by the hot-box method — Part 1 : Complete windows and doors*

JIS C 8904-9 *Photovoltaic devices — Part 9 : Solar simulator performance requirements*

NOTE Normative reference in the corresponding International Standard : IEC 60904-9 *Photovoltaic devices — Part 9 : Solar simulator performance requirements*

JIS R 3106 *Testing method for transmittance, reflectance and emissivity of flat glass and calculation of total solar energy transmittance of glazing*

NOTE Normative reference in the corresponding International Standard : ISO 9050 *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

JIS Z 8401 *Rounding of numbers*

ISO 9845-1 *Solar energy — Reference solar spectral irradiance at the ground at*

different receiving conditions — Part 1 : Direct normal and hemispherical solar irradiance for air mass 1,5

ISO 15099 *Thermal performance of windows, doors and shading devices — Detailed calculations*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS A 0202**, **JIS A 1420**, **JIS A 4710**, **JIS C 8904-9**, **ISO 9845-1** and **ISO 15099** apply.

4 Symbols and subscripts

For the purpose of this Standard, the symbols and units given in Table 1 and subscripts given in Table 2 apply.

Table 1 Symbols and units

Sym- bol	Quantity	Unit
A	Area	m^2
C_p	Specific heat	$\text{J}/(\text{kg} \cdot \text{K})$
d	Thickness	m
e	Absolute error	—
E	Spectral distribution	—
h	Surface coefficient of heat transfer	$\text{W}/(\text{m}^2 \cdot \text{K})$
H	Height	m
I	Irradiance, density of heat flow rate of incident radiation (energy per unit area per unit time resulting from incident radiation)	W/m^2
k	Coverage factor	—
l	Length	m
P	Confidence level	%
q	Density of heat flow rate (energy per unit area per unit time resulting from radiative and/or convective and/or conductive heat transfer)	W/m^2
q_i	Elements of solar absorptance that are re-emitted to the internal side	—
R	Thermal resistance or thermal resistance of surface heat transfer	$\text{m}^2 \cdot \text{K}/\text{W}$
T	Absolute temperature	K
U	Thermal transmittance	$\text{W}/(\text{m}^2 \cdot \text{K})$
V	Volume	m^3
V_e	Voltage	mV
W	Width	m
W_e	Electrical power	W
α	Absorptance	—
β	Angle from normal incidence of the irradiation	$^\circ$
γ	Parameter representing the location of the absorptance	—
Δ	Difference	—
ε	Corrected emissivity	—
ζ	Efficiency of solar energy conversion	—
η	Solar heat gain coefficient	—
θ	Celsius temperature	$^\circ\text{C}$
λ	Thermal conductivity	$\text{W}/(\text{m} \cdot \text{K})$
λ	Wavelength	nm
ρ	Reflectance	—
ρ_d	Density	kg/m^3
τ	Transmittance	—
Φ	Heat flow rate (energy per unit time resulting from radiative and/or convective and/or conductive heat transfer)	W

Table 2 Subscripts

Subscripts	Significance
abs	Absorber
av	Average
B	Planes of peripheral wall of the metering box
box	Metering box
C	Cooling device
cal	Calibration panel
case1	Case 1
case2	Case 2
case3	Case 3
ex	External
exp	Measuring conditions
F	Internal fan
g	Glazing
gap	Gap
H	Heating device
i	Index
in	Internal or inlet
i	Index
k	Index
l	Index
low	Lower limit
m	Measured
max	Maximum
N	Without irradiance
ne	Environmental external
ni	Environmental internal
out	Outlet
P	Surround panel
ps	Internal dimensions of test speci- men
r	Reflection
ref	Reference condition
se	External surface
si	Internal surface
sim	Solar simulator
Solar	Incident radiation
sp	Test specimen
st	Standardized
t	Heat flow meter
up	Upper limit
'	Without irradiation or with respect to the incidence to the internal side

5 Principle

5.1 General

The solar heat gain coefficient can be determined according to the same principle equations that are described as in **ISO 15099**, Formula (14). Therefore, the determination of the solar heat gain coefficient of windows and doors involves two stages.

- a) **First stage** Measure the density of heat flow rate through the test specimen with irradiance (solar heat gain + thermal transmission).
- b) **Second stage** Measure the density of heat flow rate through the test specimen without irradiance (thermal transmission).

The net density of heat flow rate of incident radiation is determined by the radiometer in front of the test specimen during the first stage.

The net density of heat flow rate of the solar heat gain is determined as the difference between the net density of heat flow rate measured in the first stage and the net density of heat flow rate due to thermal transmission, which is evaluated using the thermal transmittance measured in the second stage.

Since the measured solar heat gain coefficient, η_m , of windows and doors is the ratio of the net density of heat flow rate of the solar heat gain to the net density of heat flow rate of incident radiation, it shall be calculated using Formula (1) with or without shading devices :

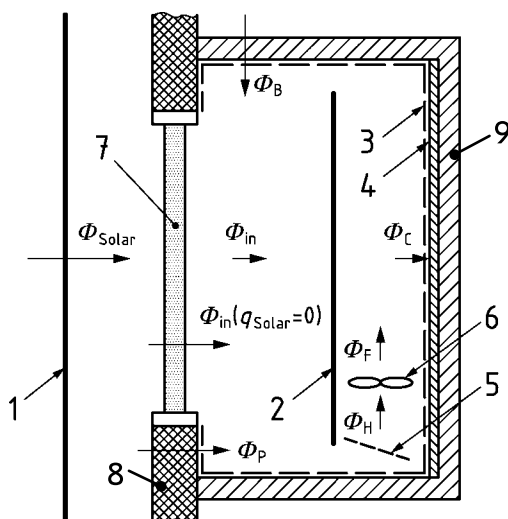
$$\eta_m = \frac{q_{in} - q_{in}(q_{Solar} = 0)}{q_{Solar}} \dots\dots\dots (1)$$

- where,
- q_{Solar} : net density of heat flow rate of incident radiation (W/m²)
 - q_{in} : net density of heat flow rate through the test specimen with irradiance (W/m²)
 - $q_{in}(q_{Solar} = 0)$: net density of heat flow rate through the test specimen due to thermal transmission without irradiance when the temperature difference between internal side and external side is ($\theta_{ne} - \theta_{ni}$) (W/m²)

All of the effects such as changes in the surface coefficient of heat transfer caused by the irradiance shall be included in the solar heat gain coefficient.

5.2 Measurement of heat flow rates with irradiance

An example of the heat flow rates with irradiance is shown in Figure 1.



Key

1 : external side baffle	Φ_B :	heat flow rate through the planes of peripheral wall of the metering box with irradiance
2 : internal side baffle	Φ_C :	heat flow rate removed by the cooling device with irradiance
3 : heat flow measuring device	Φ_F :	heat flow rate supplied by the one or more internal fans with irradiance (zero when the internal fans are not installed)
4 : cooling device	Φ_H :	heat flow rate supplied by the heating device with irradiance (zero when the heating device is not installed)
5 : heating device (optional)	Φ_{in} :	net heat flow rate through the test specimen with irradiance
6 : one or more internal fans (optional)	$\Phi_{in}(q_{Solar}=0)$:	net heat flow rate through the test specimen due to thermal transmission without irradiance when the temperature difference between internal side and external side is $(\theta_{ne} - \theta_{ni})$
7 : test specimen	Φ_P :	heat flow rate through the surround panel with irradiance
8 : surround panel	Φ_{Solar} :	net heat flow rate of incident radiation
9 : peripheral wall of the metering box		

NOTE This figure shows the case of a condition when the environmental external temperature is higher than the environmental internal temperature. In the case of a reverse condition, the directions of the heat flow through the test specimen and the surround panel due to thermal transmission will be reversed.

Figure 1 Example of heat flow rates with irradiance

The net density of heat flow rate of the incident radiation, q_{Solar} , shall be calculated using Formula (2) :

$$q_{Solar} = \frac{\Phi_{Solar}}{A_{sp}} = \frac{I_{Solar} \times A_{sp} - I_r \times A_g}{A_{sp}} \dots \dots \dots (2)$$

- where,
- Φ_{Solar} : net heat flow rate of incident radiation (W)
 - I_{Solar} : density of heat flow rate of the incident radiation (W/m²)
 - A_{sp} : projected area of the test specimen (m²)
 - I_r : density of heat flow rate of the incident radiation that is transmitted to the external side of the metering box after being reflected in the internal side of the metering box (W/m²)
 - A_g : glazing area of the test specimen (m²)

If I_r is proved to be negligible ($I_r \approx 0$), the net density of heat flow rate of the incident

radiation, q_{Solar} , shall be calculated using Formula (3) which results in the second term on the right side of Formula (2) to become 0.

$$q_{\text{Solar}} = \frac{\Phi_{\text{Solar}}}{A_{\text{sp}}} = I_{\text{Solar}} \dots\dots\dots (3)$$

Whether I_r is negligible or not, it shall be evaluated by means of 7.2 and Annex C.

The net density of heat flow rate through the test specimen with irradiance, q_{in} , shall be calculated using Formula (4) :

$$q_{\text{in}} = \frac{\Phi_{\text{in}}}{A_{\text{sp}}} = \frac{\Phi_{\text{C}} - \Phi_{\text{B}} - \Phi_{\text{F}} - \Phi_{\text{H}} - \Phi_{\text{P}}}{A_{\text{sp}}} \dots\dots\dots (4)$$

where, Φ_{in} : net heat flow rate through the test specimen with irradiance (W)
 Φ_{C} : heat flow rate removed by the cooling device with irradiance (W)
 Φ_{B} : heat flow rate through the planes of peripheral wall of the metering box with irradiance (W)
 Φ_{F} : heat flow rate supplied by the one or more internal fans with irradiance (zero when the internal fans are not installed) (W)
 Φ_{H} : heat flow rate supplied by the heating device with irradiance (zero when the heating device is not installed) (W)
 Φ_{P} : heat flow rate through the surround panel with irradiance (W)

5.3 Determination of the net density of heat flow rate due to thermal transmission

The net density of heat flow rate through the test specimen due to thermal transmission without irradiance, $q_{\text{in}} (q_{\text{Solar}} = 0)$, shall be calculated using Formula (5) :

$$q_{\text{in}} (q_{\text{Solar}} = 0) = \frac{\Phi_{\text{in}} (q_{\text{Solar}} = 0)}{A_{\text{sp}}} = U_{\text{N}} \times (\theta_{\text{ne}} - \theta_{\text{ni}}) \dots\dots\dots (5)$$

where, $\Phi_{\text{in}} (q_{\text{Solar}} = 0)$: net heat flow rate through the test specimen due to thermal transmission without irradiance when the temperature difference between internal side and external side is $(\theta_{\text{ne}} - \theta_{\text{ni}})$ (W)
 U_{N} : thermal transmittance of the test specimen without irradiance [W/(m²·K)]
 θ_{ne} : environmental external temperature with irradiance (°C)
 θ_{ni} : environmental internal temperature with irradiance (°C)

The environmental temperature may be considered as the air temperature; in this case, a statement to this effect shall be included in the report.

5.4 Measurement of heat flow rates without irradiance

The thermal transmittance of the test specimen without irradiance, U_{N} , shall be calculated using Formula (6) :

$$U_{\text{N}} = \frac{q'_{\text{in}} (q_{\text{Solar}} = 0)}{\theta'_{\text{ne}} - \theta'_{\text{ni}}} \dots\dots\dots (6)$$

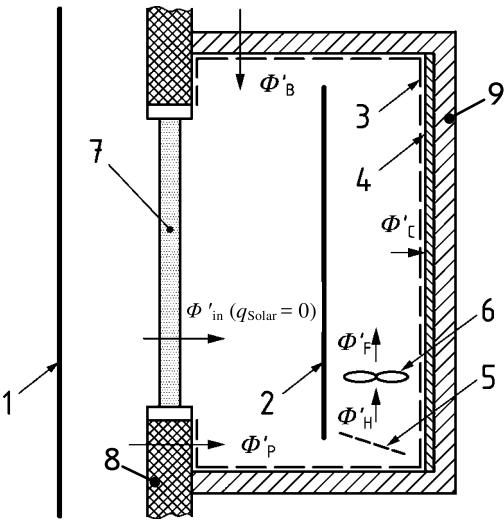
where, $q'_{\text{in}} (q_{\text{Solar}} = 0)$: net density of heat flow rate through the test specimen due to

thermal transmission without irradiance when the temperature difference between internal side and external side is $(\theta'_{ne} - \theta'_{ni})$ (W/m²)

- θ'_{ne} : environmental external temperature without irradiance (°C)
- θ'_{ni} : environmental internal temperature without irradiance (°C)

The environmental temperature may be considered as the air temperature; in this case, a statement to this effect shall be included in the report.

In the case when $(\theta'_{ne} - \theta'_{ni})$ is too small, U_N shall be estimated by means of Annex B.
An example of the heat flow rates without irradiance is shown in Figure 2.



Key		
1 : external side baffle	Φ'_B :	heat flow rate through the planes of peripheral wall of the metering box without irradiance
2 : internal side baffle	Φ'_C :	heat flow rate removed by the cooling device without irradiance
3 : heat flow measuring device	Φ'_F :	heat flow rate supplied by the one or more internal fans without irradiance (zero when the internal fans are not installed)
4 : cooling device	Φ'_H :	heat flow rate supplied by the heating device without irradiance (zero when the heating device is not installed)
5 : heating device (optional)	$\Phi'_{in}(q_{Solar} = 0)$:	net heat flow rate through the test specimen due to thermal transmission without irradiance when the temperature difference between internal side and external side is $(\theta'_{ne} - \theta'_{ni})$
6 : one or more internal fans (optional)	Φ'_P :	heat flow rate through the surround panel without irradiance
7 : test specimen		
8 : surround panel		
9 : peripheral wall of the metering box		

NOTE This figure shows the case of a condition when the environmental external temperature is higher than the environmental internal temperature. In the case of a reverse condition, the directions of the heat flow through the test specimen and the surround panel due to thermal transmission will be reversed.

Figure 2 Example of heat flow rates without irradiance

The net density of heat flow rate through the test specimen due to thermal transmission without irradiance, $q'_{\text{in}}(q_{\text{Solar}} = 0)$, shall be calculated using Formula (7) :

$$q'_{\text{in}}(q_{\text{Solar}} = 0) = \frac{\Phi'_{\text{in}}(q_{\text{Solar}} = 0)}{A_{\text{sp}}} \\ = \frac{\Phi'_C - \Phi'_B - \Phi'_F - \Phi'_H - \Phi'_P}{A_{\text{sp}}} \dots\dots\dots (7)$$

where, $\Phi'_{\text{in}}(q_{\text{Solar}} = 0)$: net heat flow rate through the test specimen due to thermal transmission without irradiance when the temperature difference between internal side and external side is $(\theta'_{\text{ne}} - \theta'_{\text{ni}})$ (W)

Φ'_C : heat flow rate removed by the cooling device without irradiance (W)

Φ'_B : heat flow rate through the planes of peripheral wall of the metering box without irradiance (W)

Φ'_F : heat flow rate supplied by the one or more internal fans without irradiance (zero when the internal fans are not installed) (W)

Φ'_H : heat flow rate supplied by the heating device without irradiance (zero when the heating device is not installed) (W)

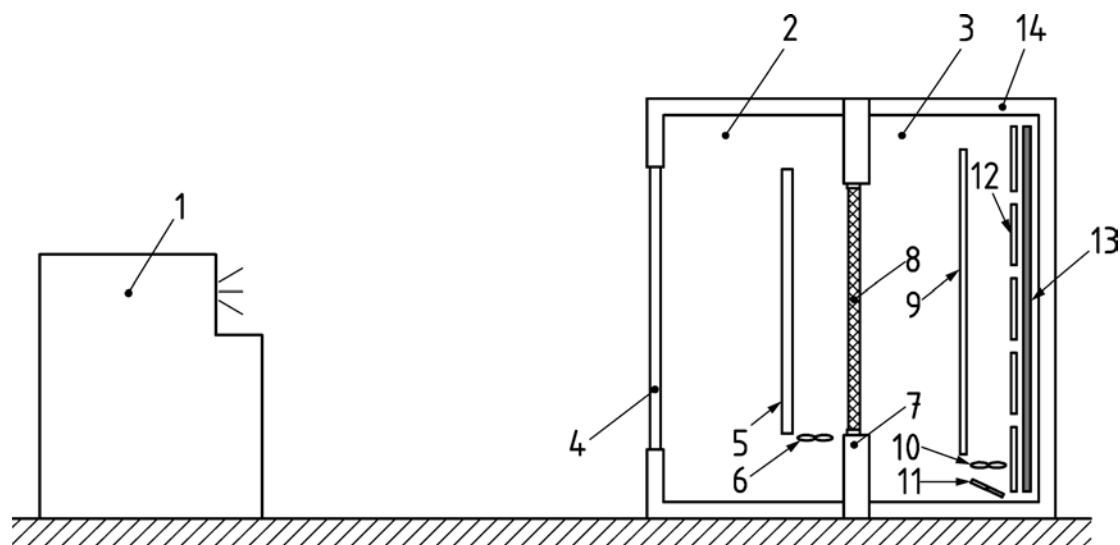
Φ'_P : heat flow rate through the surround panel without irradiance (W)

6 Test apparatus and specimens

6.1 Construction and summary of the test apparatus

6.1.1 Construction of the test apparatus

The test apparatus mainly consists of a solar simulator, a climatic chamber, and a metering box. Details of each component of the test apparatus are given in 6.2 to 6.6. An example of the overall construction of the test apparatus is shown in Figure 3.



Key

- | | |
|--------------------------------|---|
| 1 : solar simulator | 8 : test specimen |
| 2 : climatic chamber | 9 : internal side baffle |
| 3 : metering box | 10 : one or more internal fans (optional) |
| 4 : transparent aperture | 11 : heating device (optional) |
| 5 : external side baffle | 12 : heat flow measuring device |
| 6 : external airflow generator | 13 : cooling device |
| 7 : surround panel | 14 : peripheral wall of the metering box |

Figure 3 Example of overall construction of the test apparatus

6.1.2 Summary of the test apparatus

The test apparatus can be summarized as follows.

- Light emitted by the solar simulator passes through the transparent aperture and is then directed towards the test specimen. The light passing through the test specimen is absorbed by the cooling device.
- The transparent aperture is installed in the climatic chamber in order to allow the light from the solar simulator to pass through to the test specimen.
- The external airflow generator and the external side baffle with transparency may be installed in the climatic chamber in order to adjust the external surface coefficient of heat transfer and environmental external temperature.
- The cooling device is installed opposite the test specimen in the metering box in order to remove the solar heat gain and the thermal transmission that has entered the metering box.
- The heating device and the internal side baffle with transparency may be installed in the metering box in order to adjust the internal surface coefficient of heat transfer and environmental internal temperature.
- One or more internal fans may be installed in the metering box in order to stir the internal air to obtain a uniform temperature distribution and/or to adjust the in-

ternal surface coefficient of heat transfer.

- g) All of the heat flow rates passing through the metering box are measured by the heat flow measuring device in order to determine the net heat flow rate through the test specimen.
- h) All the walls, the floor and the ceiling of the laboratory shall be covered with the coating of solar reflectance of 0.05 or lower in order to avoid stray light.

6.2 Solar simulator

A steady-state solar simulator shall be used, which meets the following requirements.

- a) **Spectral match of the irradiance** : The spectral match of the irradiance to all wavelength ranges specified in Table 3 shall be measured in accordance with **JIS C 8904-9** and shall be within 0.55 to 1.45. Examples of spectral match of the irradiance are shown in Table D.1.

NOTE The percentages of total irradiance for nine wavelengths ranges given in Table 3 have been determined as the deviation from the direct reference solar spectral irradiance for air mass 1.5 in accordance with **ISO 9845-1**.

Table 3 Percentage of total irradiance in the wavelength range 300 nm to 2 500 nm (given in ISO 9845-1)

No.	Wavelength range ^{a)} (nm)	Percentage of total irradiance in the wavelength range 300 nm to 2 500 nm (%)
1	300 to 400	2.9
2	400 to 500	11.3
3	500 to 600	14.1
4	600 to 700	13.5
5	700 to 800	11.8
6	800 to 900	10.1
7	900 to 1 100	13.5
8	1 100 to 1 700	16.8
9	1 700 to 2 500	5.9
Note ^{a)} The wavelength ranges are in accordance with JIS C 8904-9 .		

- b) **Non-uniformity of the irradiance** : The non-uniformity of the irradiance on the test plane shall be measured in accordance with **JIS C 8904-9** and shall be within 5 %. However, the designated test area shall be divided into at least 16 points, alternatively.
- c) **Temporal instability of the irradiance** : Temporal instability of the irradiance on the test plane shall be measured by the procedure for long term instability (LTI) in accordance with **JIS C 8904-9** and shall be within 5 %.
- d) **Maximum angle of irradiance** : The maximum angle of irradiance to the test spec-

imen shall be within 10°.

- e) **Area of effective irradiance** : The width and height of the area of effective irradiance shall be 100 % or greater than each dimension of the test specimen width, W_{sp} , and height, H_{sp} .

6.3 Climatic chamber

The climatic chamber shall meet the following requirements.

- a) **General** The general climatic chamber is constructed of the following : a transparent aperture, an external airflow generator and an external side baffle. It maintains the environmental external conditions (see Figure 3).
- b) **Transparent aperture** : The transparent aperture is installed in order to allow the light from the solar simulator to pass through the climatic chamber to the test specimen. The transparent aperture shall be made from high-transmittance glass specified as follows :
 - 1) the solar transmittance of each glass pane according to **JIS R 3106** shall be 88.0 % or higher;
 - 2) the difference between the maximum and minimum value of the spectrum transmittance according to **JIS R 3106**, Table 4 within a range of 380 nm to 2 100 nm shall be 0.050 or lower.
- c) **External airflow generator** : The external airflow generator is installed in order to maintain the external surface coefficient of heat transfer on the test specimen. The airflow shall be parallel to the test specimen and the surround panel. The appropriate air speed shall be set to maintain the external surface coefficient of heat transfer.
- d) **External side baffle** : The external side baffle with transparency may be installed in order to form and maintain the environmental external conditions between the external side baffle, the test specimen and the surround panel. The external side baffle shall be made from high-transmittance glass. The external side baffle may also serve as a transparent aperture.

NOTE The external side baffle is very useful to set up the environmental external conditions. More details are presented in **JIS A 4710**.

6.4 Metering box

The metering box shall meet the following requirements.

- a) **General** The metering box shall be constructed from the following : a cooling device, an internal side baffle, heating device (optional) and internal fans (optional). It maintains the environmental internal conditions (see Figure 3). The appropriate heat flow measuring devices such as heat flow meter and so forth shall be used in order to measure all of the heat flow rates passing through the metering box.
- b) **Cooling device** : The cooling device is installed opposite to the test specimen in order to remove all the heat entering the metering box. The surface of the cooling de-

vice shall have a solar absorptance of 0.90 or greater and have a matte finished to maximize heat absorption. The heat flow meters or the calorimeter may be used as the heat flow measuring device. The refrigerant set a temperature lower than environmental internal temperature, is circulated over the rear surface of the cooling device. Environmental internal temperature is controlled by either the heating device, the inlet temperature of the refrigerant or the volumetric flow rate of the refrigerant or by a combination of these three.

- c) **Internal side baffle** : The internal side baffle with transparency may be installed in order to form and maintain the environmental internal conditions between the internal side baffle, the test specimen and the surround panel. The internal side baffle is very useful to set up the environmental internal conditions. More details are presented in **JIS A 4710**. The internal side baffle shall be made from high-transmittance glass.
- d) **Heating device** (optional) : The heating device may be installed in the metering box to control environmental internal temperature. The electrical power used for heating shall be measured.
- e) **One or more internal fans** (optional) : The one or more internal fans may be installed in the metering box in order to stir the internal air to obtain a uniform temperature distribution and/or to adjust the internal surface coefficient of heat transfer. The electrical power used for stirring the air shall be measured.

6.5 Surround panels

The surround panels shall be used to hold the test specimen in the correct position and to separate the climatic chamber side from the metering box side.

The heat flow rate through the surround panels shall be determined, for example, by measuring it with heat flow measuring devices that are attached to the surface of the surround panel on the metering box side and/or climatic chamber side or by calculating it based on the temperature difference between the surface of the surround panel on the metering box side and climatic chamber side.

NOTE An example of the design of the surround panel is shown in Annex D.

6.6 Calibration panels

The calibration panels shall be in accordance with **JIS A 4710** and shall be of a size similar to the test specimen.

NOTE They are used to set up the measuring conditions of the surface coefficients of heat transfer.

6.7 Metering location of temperatures and irradiance

Metering location of temperatures and irradiance shall be as follows.

- a) The surface temperatures of the calibration panels shall be measured on the climatic chamber side and the metering box side. Temperatures shall be measured by appropriate methods at appropriate locations (see Annex E).
- b) The air temperatures and the baffle surface temperatures of the metering box side

shall be measured using the same layout of the surface temperatures grid on the calibration panel. Examples of the temperature measurement are shown in Annex E.

- c) The distance between the air temperature sensors and the surfaces of the surround panel of both the climatic chamber and metering box sides shall be approximately 100 mm.
- d) The net density of heat flow rate of the incident radiation, q_{Solar} , shall be measured by a radiometer installed on the climatic chamber side directly facing the light source. The position of the radiometer shall be near the centre of the test specimen and not cast a shadow on the temperature sensor. The distance between the radiometer and the surface of the surround panel shall be approximately 50 mm.
- e) The temperature sensors shall have the mechanism to eliminate the effects due to irradiance as much as possible.

6.8 Test specimen

The test specimen shall fill the surround panel aperture, in accordance with the actual construction.

The clearance between the surround panel and the test specimen frame shall be 5 mm or less, and the perimeter joints between the surround panel and the specimen shall be sealed with tape, caulking or masking material. The test specimen mounting and heat transfer aperture dimensions shall be in accordance with JIS A 4710, Annex JA.

7 Measurement procedure

7.1 Measurement

Measurements shall be performed in each case with and without irradiance. Environmental conditions are shown in Table 4.

Table 4 Environmental conditions ^{a)}

Element		Summer	Winter
Internal temperature, θ_{in}	°C	25	20
External temperature, θ_{ex}	°C	30	0
Internal surface coefficient of heat transfer ^{b)} , h_{si}	W/(m ² ·K)	8	8
External surface coefficient of heat transfer ^{b)} , h_{se}	W/(m ² ·K)	14	24
Density of heat flow rate of incident radiation ^{c)} , q_{Solar}	W/m ²	500	300
NOTE The performance requirements of windows and doors are the solar shading in summer and the solar heat gain in winter. Therefore, this Standard specifies each of the environmental conditions. Note ^{a)} Environmental conditions have been set based on Table 4 of JIS A 2103. Note ^{b)} Internal and external surface coefficients of heat transfer shall be determined as specified in Annex A. Note ^{c)} Irradiance shall be normal incidence to the test plane. If the solar simulator cannot meet the density of heat flow rate of the incident radiation, q_{Solar}, under summer conditions, the value may be 400 W/m² or higher and the maximum density of heat flow rate.			

The tolerance for the air temperature or environmental temperature difference between internal side and external side during measurements shall be $\pm 2\text{ }^{\circ}\text{C}$ or $\pm 5\text{ }^{\circ}\text{C}$, respectively, of the set value. The difference between the environmental temperatures and the reference temperatures shall be less than 5 K. The tolerance for the density of heat flow rate of the incident radiation shall be $\pm 10\text{ W/m}^2$ of the set value.

The metering location of the metering box side shall be the same as the layout of the air temperatures grid in the case when the surface temperatures of the test specimen and baffle are measured. Examples of the temperature measurement are shown in Annex E.

The relative humidity in the climatic chamber and metering box shall be kept at low enough levels to avoid condensation or other factors.

The heat flow rates through the test specimen and others are as shown in Clause 5.

The measurement set-up shall reach steady state conditions before valid measurements with or without irradiation can be performed. The steady state conditions shall be checked as follows.

- a) The air temperature difference between the external and internal sides and the density of heat flow rate passing through the specimen shall be used as the parameters.
- b) Measurements of the parameters given in a) shall be taken at shortest intervals allowing measurement for a duration of 10 min, and then averaged over the duration.
- c) The procedure in b) shall be carried out three times with 5 min or longer intervals.
- d) When the three measured values of all of the parameters obtained in c) do not deviate more than 1 % from the average, and the variation of the three values is not in a uniform direction, steady state conditions can be assumed.

After the steady state conditions have been reached, parameters necessary for determination of thermal transmittance by measurement without irradiance or solar heat gain coefficient by measurement with irradiance shall be measured at the same intervals as used for checking of steady state conditions. Measurement shall be continued for at least 30 min, and the measured values obtained during this duration shall be averaged.

7.2 Expression of results for reference conditions

As the solar heat gain coefficient depends on conditions such as the external airflow and the spectrum of the irradiance, the measuring conditions during measurements should be close to the reference environmental conditions in Table 4. However, it is difficult to realize exactly the reference environmental conditions. Therefore, the measured solar heat gain coefficient, η_m , is necessary either to prove that the difference between both conditions is negligible or to correct η_m to η_{st} , standardized solar heat gain coefficient. In following cases, it shall be checked and corrected according to the methods specified in Annex C.

- a) Correction and sensitivity analysis of the effect of the non-ideal black absorber: This correction shall be done in the case when irradiation reflected back to the external side of the metering box, I_r , is not negligible. In the case of negligible level, it shall be proved.
- b) Correction and sensitivity analysis for a non-reference spectrum of the solar simulator.
- c) Correction and sensitivity analysis for non-reference external and internal convective heat transfer conditions : This correction may be used in the case to correct to specific surface coefficients of heat transfer.

8 Test report

8.1 Test report contents

The test report shall contain the following information :

- a) number and title of this Standard;
- b) identification of the organization performing the measurement;
- c) date of measurement;
- d) environmental conditions;
- e) all details necessary to identify the test specimen :
 - 1) specifications such as the name, type, width, height, thickness, material, colour, and other elements of the frame, glazing, shading device, opaque panel, or other components;
 - 2) the technical drawing (cross-sections) of the test specimen;
- f) results of measurement.

The results of measurement listed in Table 5 shall be indicated. The results of the solar heat gain coefficient shall be rounded off to two decimal places according to Rule B of JIS Z 8401.