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Test method for performance of building airtightness by fan pressurization

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Land, Infrastructure and Transport through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from the Japan Testing Center for Construction Materials (JTCCM)/the Japanese Standards Association (JSA), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

This Standard has been made based on **ISO 9972 : 1996** *Thermal insulation—Determination of building airtightness—Fan pressurization method* for the purposes of making it easy to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of International Standard which is based on Japanese Industrial Standard.

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

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Test method for performance of building airtightness by fan pressurization

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO 9972** *Thermal insulation—Determination of building airtightness—Fan pressurization method* published in 1996.

The criteria of the airtightness of buildings in Japan are shown in the Notification No. 2 of the Ministry of International Trade and Industry and the Ministry of Construction (Criteria of Judgement of the Client on the Rationalization of Energy Use with respect to Buildings) which was shown in 1992 before the International Standard was established, and in connection with it, the test method is also already established. Then, this Standard was prepared with the contents including both standards. Therefore, although the technical contents of the International Standard are not altered, articles are altered, or requirements which are not needed currently for the measurement in Japan in the light of the difference of the buildings under consideration are deleted. A list of modifications with explanations is shown in Annex 5 (informative).

1 Scope This Standard specifies the test method for performance of buildings and building components used mainly as residences by inducing an inside-outside building pressure difference using fans.

- Remarks 1 The residence in this Standard refers to one dwelling unit, such as a single-family house, an apartment house, or a row-house. General buildings are also applicable according to this Standard.
- 2 The method inducing an inside-outside building pressure difference consists of pressurizing the inside of the building or depressurizing the inside of the building, which are called the pressurization method and the depressurization method, respectively.
- 3 The International Standard corresponding to this Standard is as follows:

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**.

ISO 9972 : 1996 *Thermal insulation—Determination of building airtightness—Fan pressurization method* (MOD)

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standard (including amendments) indicated below shall be applied.

JIS B 8330 *Testing methods for turbo-fans*

JIS Z 8762 *Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits running full*

3 Definitions and symbols

3.1 Definitions For the purposes of this Standard, the following definitions shall apply:

- a) **performance of airtightness** Performance of airtightness means the degree of sealing of the boundary or barrier separating the interior volume of an actual building from the outside environment (building envelope) or building component separating the interior of a building from the outside environment, and is expressed as the total equivalent leakage area or the equivalent leakage area.

Remarks : Since the outside enclosure of a building is a criteria of performance of airtightness of the building, the doors of each room are left open so that the inside of building can be regarded as single space, and the pressure becomes uniform for a building having many rooms. Furthermore, the performance of airtightness of a building and building component depends on the leakage area between parts which separate the inside and the outside, and the leakage area is determined by the connection section and crack of building component, porous materials, the opening-and-closing part of windows and doors, etc., the surrounding of penetrating piping and ducts, the mailbox attached to a door, etc.

- b) **building envelope** A building component, such as an outer wall, a roof, a ceiling, a foundation, a floor, and an opening section, etc., which is a part separating the inside and the outside of a building airtightly.

Remarks : In an apartment house, a row-house, etc., the boundary between the neighboring house and the wall, etc. is regarded as a building envelope since the residence in this Standard refers to one dwelling unit.

- c) **air flow rate Q** Air flow rate from the outside to the inside or from the inside to the outside through the building envelope or building component when the inside-outside building pressure difference is induced by a blower.
- d) **air leakage characteristic formula** A formula showing the relation of the inside-outside building pressure difference (ΔP) and air flow rate (Q) is expressed as follows.

$$Q = a(\Delta P)^{\frac{1}{n}} \dots\dots\dots (1)$$

- e) **air leakage coefficient a** A coefficient of air leakage characteristic formula, which refers to air flow rate per 1 hour when the inside-outside building pressure difference is 1 Pa
- f) **leakage area characteristic value n** Refers to the condition of leakage area and the inclination of the straight line when the air leakage characteristic formula is expressed with a logarithm.

Remarks : Generally, n is the value in the range between 1 and 2, and when the leakage area is small, n comes close to 1, and when the leakage area is large like a simple opening, n comes close to 2.

- g) **total equivalent leakage area αA** An effective area of simple opening equivalent to a leakage area calculated from air flow rate when the inside-outside building pressure difference is 9.8 Pa.

Remarks : Generally, a simple opening area A multiplied by flow coefficient α ($0 \leq \alpha \leq 1$) refers to an effective opening area or effective area.

- h) **real total floor area S** A total floor area of the section in connection with ventilation inside the building envelope in principle, which is a floor area calculated according to Annex 1 (normative).
- i) **equivalent leakage area C** An area obtained by dividing total equivalent leakage area (αA) by real total floor area (S) inside the building envelope.

3.2 Symbols and units The symbols and units shall be in accordance with Table 1.

Table 1 Symbols and units

Symbol	Name	Unit
Q	Air flow rate flowing through leakage area	m^3/h
Q_m	Air flow rate flowing through measuring device	m^3/h
ΔP	Inside-outside building pressure difference after correction	Pa
ΔP_m	Inside-outside building pressure difference when measuring	Pa
ΔP_0	Zero-flow inside-outside building pressure difference	Pa
n	Leakage area characteristic value	-- (dimensionless)
a	Air leakage coefficient	$\text{m}^3/(\text{h} \cdot \text{Pa}^{1/n})$
A	Simple opening area	cm^2
α	Flow coefficient	-- (dimensionless)
αA	Total equivalent leakage area	cm^2
C	Equivalent leakage area	cm^2/m^2
S	Real total floor area or area of building component	m^2
t	Air temperature	$^{\circ}\text{C}$
t_i	Indoor temperature	$^{\circ}\text{C}$
t_o	Outdoor temperature	$^{\circ}\text{C}$
ρ	Air density	kg/m^3

4 Test apparatus

4.1 Composition of test apparatus The test apparatus generally consists of a blower, a flow controller, an air flow measuring system, a pressure-measuring device (differential pressure gage), a temperature-measuring device, etc. as shown in Fig. 1 a) and Fig. 1 b). When measuring the leakage area of a building component, an airtight chamber or plastic sheet which is large enough to cover the building component is needed.

Remarks : The typical pressure difference inducing method is illustrated in Annex 2 (informative).

4.2 Equipment

4.2.1 Blower The blower shall be capable of setting the predetermined positive or negative pressure difference between the inside and outside of building.

4.2.2 Flow controller The flow controller shall be capable of producing a variable flow rate in the blower, and maintaining a fixed flow rate during the measurement of the flow rate at each pressure difference.

4.2.3 Air flow measuring system The air flow measuring system shall be capable of measuring with an accuracy of within $\pm 5 \%$ of the measuring range of the flow rate.

Remarks : The calibration of the air flow measuring system shall be performed periodically. The calibration of flow rate shall be in accordance with JIS B 8330, JIS Z 8762 or the like.

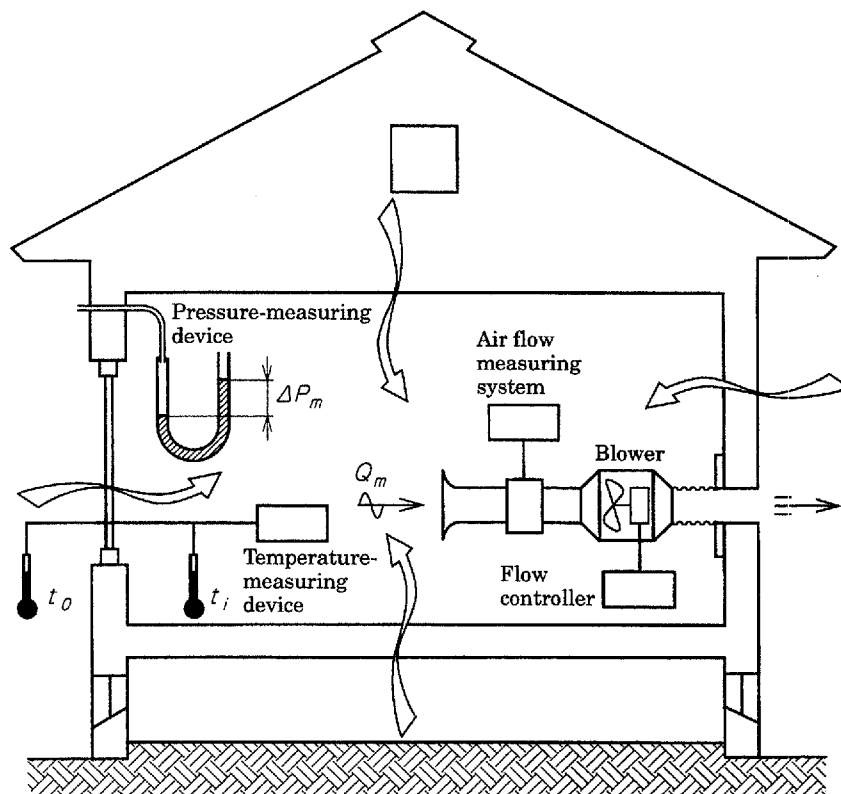
4.2.4 Pressure-measuring device The pressure-measuring device shall be capable of measuring with an accuracy of within ± 0.5 Pa in the measuring range of pressure difference of approximately 10 Pa to 100 Pa.

Remarks : The calibration of the pressure-measuring device shall be performed periodically with a calibrator which ensures traceability.

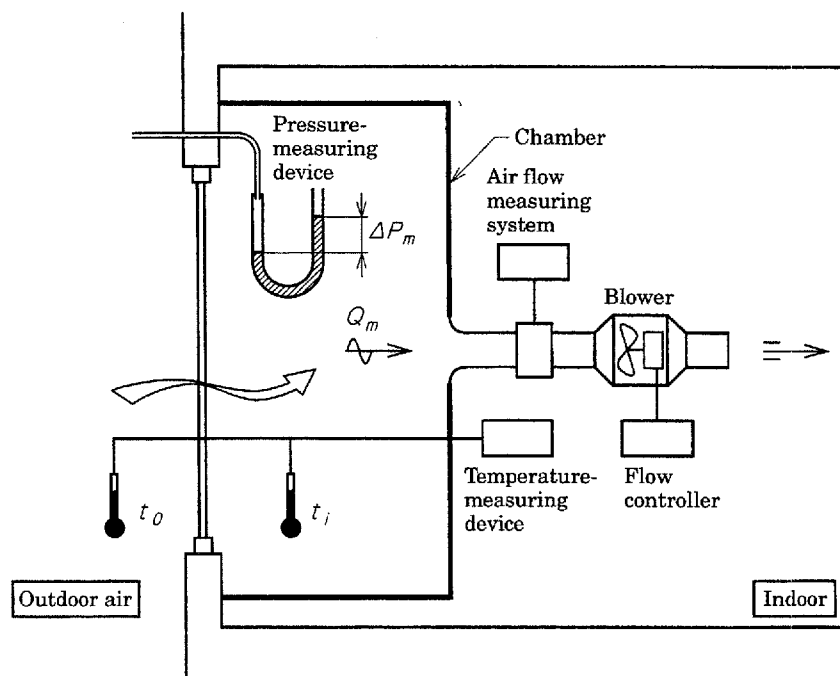
4.2.5 Temperature-measuring device The temperature-measuring device shall be capable of measuring with an accuracy of ± 1 K.

4.2.6 Other measuring instruments In order to determine the atmospheric conditions prevailing at the time of measurement, an air speedometer and a barometer shall be used.

Remarks : When not using these instruments, data available in a nearby meteorological observatory, etc. may be used.



a) When measuring building (depressurization method)



b) When measuring building component (depressurization method)

Fig. 1 Composition of test apparatus

5 Test method

5.1 In the case of measuring buildings

5.1.1 Building conditions when measuring residences The building conditions when measuring residences shall, as a rule, be as follows:

- a) Since the performance of airtightness of a building envelope is tested for the whole building, the doors, etc. of each room shall be left open so that the pressure may respond as single space. However, the sliding door of a closet which does not touch a building envelope and the door of a closet, or a cupboard can be excluded. Furthermore, the performance of airtightness of a residence shall be measured in a fully constructed building only.
- b) The roof space of roof heat insulation and the underfloor space, underground space, etc. of basic heat insulation shall be left opened if there are doors or access doors and shall be regarded as the indoor side. The roof space and underfloor space, etc. which do not have doors or access doors shall be regarded as the outdoor air side. Since the parking garage in the building is regarded as the outdoor air side, the door which leads indoors shall be left closed.
- c) The dual function supply and exhaust ventilation fan and the exhaust fan in the kitchen and toilet shall be stopped. Furthermore, the natural exhaust gas type or the compulsive exhaust gas type burning appliances, fireplaces, air conditioners, etc. shall be stopped.
- d) When the opening section, dual function supply and exhaust ventilating opening, or ventilating opening are attached to the building envelope, or where the piping and duct pass through the building envelope, treat as shown in Table 2.

**Table 2 Treatment method, such as for the opening section,
or the supply and exhaust ventilating opening**

Treatment method	No.	Building component	Opened or closed condition, etc.	Remarks
Location only closed without sealing up	1	Door and window in building envelope	Only lock	—
	2	Ceiling and underfloor access door ⁽¹⁾	Ordinarily closed condition	
	3	Mail box of door, etc.	Ordinarily closed condition	
	4	Door which leads to parking garage	Ordinarily closed condition	
	5	Door which leads to underground where both the foundation and the floor are heat-insulated.	Ordinarily closed condition	
Location which may be sealed up with tape, etc.	6	Ventilation register	Shutter closed	Air leakage shall be eliminated.
	7	Kitchen range fan	Shutter closed	
	8	Ventilating fan and ceiling fan	Shutter closed	
	9	Hole of chimney stack other than FF type	Damper closed	
	10	Drain pipe which leads to the outdoor ⁽²⁾	Water sealing condition	
	11	Entrance in the outdoor side of supply and exhaust duct of central ventilation system	—	
Location to be opened	12	Opening section in the outside of building envelope ⁽³⁾	Ordinarily opened condition	Opened without fail

Notes (1) In this case, it refers to the access door installed in the ceiling and floor of the roof space and underfloor space which are not included in the calculation of real total floor area.

(2) The surrounding of section where the piping and duct pass through the building component shall be left as it is without sealing up.

(3) For example, it refers to an air screen room, a sun parlor, etc. of the entrance.

5.1.2 Outdoor wind speed when testing When testing, the measurement shall be performed, in principle, under the condition that there is no outdoor wind speed. However, if the inside-outside building pressure difference by a fine wind speed is 3 Pa or under, the measurement may be performed.

5.1.3 Indoor temperature when testing The indoor temperature when testing shall be in the range from 5 °C to 35 °C. Furthermore, the temperature inside the building shall be as uniform as possible.

Remarks : It is desirable to measure when the product of the indoor-outdoor air temperature difference (K) and the height (m) from the lowest part of building envelope to the highest part of building envelope of the building to be measured (one dwelling unit for an apartment house)

is 200 (K·m) or under so that the effect of pressure difference induced between inside and outside the building due to the chimney effect does not cause errors when testing.

5.1.4 Measurement procedure Before measuring, confirm that the condition of the building is in accordance with the condition shown in 5.1.1 in the case of residences, and record it. Furthermore, while confirming the outline of the building envelope with the drawing, observe and record it.

- a) **Installation of test apparatus** The installation location of test apparatus shall be the opening section of the building envelope which does not have any effects on the performance of building airtightness, and a window which is as small as possible, etc. shall be selected. When there is a fine wind speed outside, it shall be installed at the opening section in the leeward side to avoid the effect of the wind. The connection of the supply and exhaust opening of test apparatus and the opening section shall be sealed up with a suitable sealing material and made airtight with tape, etc. if there is a leakage area using.

In addition, in the case where the devices, such as a blower or an air flow measuring system are separated, those connections shall also be made airtight.

- b) **Measurement of air temperature** The measurement position of indoor temperature shall be located at a place which is not subjected to the effects of sunshine or radiation from a heater in order to measure the correct indoor temperature. In the case of the depressurization method, it shall be located near to the central part of the measurement room, and in the case of the pressurization method, it shall be located at a place which is not influenced by the inflow air from the outside air when measuring, and near to the central part of the measurement room. The measurement position of outside air temperature shall be located near the building envelope, and shall not be subjected to the effects of sunshine, and shall be located at an airy place. Furthermore, the indoor temperature and outdoor air temperature shall be measured before and after testing.
- c) **Induced pressure difference** The pressure difference is induced by depressurization (depressurization method) which is obtained by rotating the blower gradually with the flow controller, and exhausting the air inside the room to the outdoors, or by pressurization (pressurization method) which is obtained by supplying outside air to the inside of the room.
- d) **Measurement of pressure difference** In order to measure the pressure difference correctly, the tube head for the measurement of pressure difference, for the inside of room, shall be installed at a place where it is difficult for the test apparatus at the time of measurement to be influenced by blowing, and for the outside of room, at a place where it is difficult for the test apparatus to be influenced by blowing or the outside wind. In principle, the location of installation shall be one place for the inside and the outside respectively.

Remarks 1 The position of pressure difference measurement in a high building like 3 stories or a building where the indoor-outdoor air temperature difference is large shall be located at such a place that the pressure comes in near the neutral zone of an up-and-down pressure distribution. Furthermore, in order to expect an accurate measurement, it is desirable to confirm that the pressure difference distribution of

the space to be measured in the building is within 10 % of inside-outside pressure difference.

- 2 In the case where pressure distributions exist at each side or at the up-and-down position of the building according to wind, etc., it is desirable to measure so that the average pressure difference at the external side of the building is obtained.
- 3 The position of outside pressure measurement in the case of a one dwelling unit of an apartment house, a row house, etc. shall be located at the outside, such as a veranda, which is not hidden behind something, such as a balustrade. Furthermore, an adjoining dwelling unit shall be in a condition with a window opened so that it can be regarded as the outside air.

In addition, in order to expect an accurate measurement, it is desirable to measure the pressure of the roof space or underfloor space located in the outside of building envelope, or the pressure of space of an adjoining dwelling unit of an apartment house, a row house, etc.

- e) **Confirmation of zero point of pressure-measuring device** Before measuring the pressure difference, the tube shall be removed, and the zero point of the differential pressure of pressure-measuring device shall be confirmed.

Remarks : Since electrical equipment, such as a pressure-measuring device, is not stabilized for about 10 min after turning on the power, the measurement shall be performed after fully warming up.

- f) **Measurement of zero-flow inside-outside building pressure difference** Seal the opening of the straightening cylinder of test apparatus, etc. before measuring, and measure the zero-flow inside-outside building pressure difference (ΔP_0). After confirming that the pressure difference at that time is 3 Pa or under, measure it. After the end of the measurement, measure the zero-flow inside-outside building pressure difference again, and after confirming that the pressure difference does not change before and after measuring, end the measurement process. If a pressure difference of 1 Pa or over exists before and after measuring, repeat the measurement.

In addition, when the inside-outside building pressure difference is 3 Pa or under, for the measurement device capable of performing the zero adjustment of pressure difference under this condition, the measurement can be started after zero adjustment. Even in this case, after the end of measurement, measure the zero-flow inside-outside building pressure difference, and confirm that the pressure difference does not change. When a pressure difference of 1 Pa or over exists before and after measuring, repeat the measurement.

Remarks : The pressure difference at zero flow rate shall be used as a correction value for determining the true pressure difference. When the zero-flow pressure difference changes before and after measuring, repeat the measurement.

- g) **Measurement of air flow rate** The air flow rate shall be measured at 5 points or over within measurement range so that the measurement range of pressure difference intervals are nearly equal by changing the pressure difference with