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Heat recovery ventilators and energy recovery ventilators — Method of test for performance

Ventilateurs-récupérateurs de chaleur et ventilateurs-récupérateurs d'énergie — Méthode d'essai des performances

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Contents

Foreword

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The committee responsible for this document is ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 6, *Testing and rating of air-conditioners and heat pumps*.

Heat recovery ventilators and energy recovery ventilators — Method of test for performance

1 Scope

This International Standard prescribes a method of testing the ventilation and energy related performance of heat recovery ventilators (HRVs)and energy recovery ventilators (ERVs) that do not contain any supplemental heating (except for defrost), cooling, humidification or dehumidification components.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3966:2008, *Measurement of fluid flow in closed conduits — Velocity area method using Pitot static tubes*

ISO 5167-1:2003, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements*

ISO 5801:2007, *Industrial fans — Performance testing using standardized airways*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
outdoor airflow
OA
volume of outside air entering the ventilator

Note 1 to entry: Indicated in Figure 1 as 1.

Note 2 to entry: Also referred to as 'entering supply air'.

3.2
supply airflow
SA
outside air after passing through the ventilator

Note 1 to entry: Indicated in Figure 1 as 2.

Note 2 to entry: Also referred to as 'leaving supply air'.

3.3
return (extract) airflow
RA
indoor air entering the ventilator

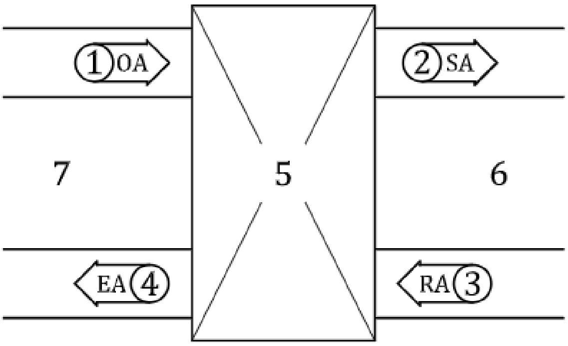
Note 1 to entry: Indicated in Figure 1 as 3.

Note 2 to entry: Also referred to as 'entering exhaust air'.

3.4
exhaust airflow
EA
indoor air after passing through the ventilator

Note 1 to entry: Indicated in Figure 1 as 4.

Note 2 to entry: Also referred to as 'leaving exhaust air'.



Key

1 outdoor airflow (OA) (entering)
2 supply airflow (SA) (leaving)
3 return airflow (RA) (entering)
4 exhaust airflow (EA) (leaving)
5 ventilator
6 indoor side
7 outdoor side

Figure 1 — Schematic numbering of airflows for heat and energy recovery ventilators

3.5
station
location in the test apparatus at which conditions such as temperature, humidity, pressure, or airflow are measured

Note 1 to entry: These locations are identified as "station 1", "station 2", "station 3" and "station 4" for each of the airflows indicated in Figure 1.

3.6
coefficient of energy
COE
total exchanged energy between the airstreams plus the power value of moving air, divided by the power input

Note 1 to entry: The equation for determining the coefficient of energy is given in 8.6.

3.7
rating points
sets of supply and return airflows, static pressures at inlets and outlets, and speed control setting, achieved during the airflow performance measurement, at which thermal performance tests (and exhaust air transfer tests, if applicable) are performed

3.8
effective work
EW
total exchanged energy between the airstreams plus the power value of moving air minus the power input

Note 1 to entry: The equation for determining the effective work is given in 8.7.

Note 2 to entry: Effective work is expressed in W.

3.9
power value of moving air
rate of pressure energy and kinetic energy of the air delivered by the ventilator

Note 1 to entry: The equation that determines the power value of moving air is given in 8.6.1.

Note 2 to entry: Power value of moving air is expressed in J/s for P_{vma}.

3.10
gross effectiveness
measured effectiveness, not adjusted for leakage, motor heat gain, or heat transfer through the unit casing

Note 1 to entry: The sensible, latent or total gross effectiveness of an HRV or ERV, at equal airflows, is described in 8.5.

3.11
maximum rated airflow
the largest supply and return airflows, specified by the manufacturer, at which an airflow test is performed

Note 1 to entry: For ventilators with speed control devices, different maximum rated airflows may be defined for each speed control setting at which the test is performed.

3.12
minimum rated airflow
the smallest supply and return airflows, specified by the manufacturer, at which an airflow test is performed

Note 1 to entry: For ventilators with speed control devices, different minimum rated airflows may be defined for each speed control setting at which the test is performed.

3.13
net supply airflow
portion of the leaving supply airflow that originated as entering supply airflow

Note 1 to entry: The net supply airflow is represented by the variable Q_{SANet}, measured in m^3/s.

Note 2 to entry: The equations for determining net supply airflow are given in 8.4.1 (ducted units) and 8.4.2 (unducted units).

3.14
net supply airflow ratio
ratio determined by dividing net supply airflow by supply airflow

Note 1 to entry: Expressed as a percentage, and described in 8.4.1 and 8.4.2.

3.15
speed control device
device incorporated into the ventilator which controls the speed of the fan

3.16
standard air
dry air with a density of 1,2 kg/m^3

Note 1 to entry: These conditions approximate dry air at 20°C and 101,325 kPa absolute.

3.17
static pressure differential
absolute difference between inlet static pressure and outlet static pressure for each of the two airstreams

EXAMPLE Static pressures measured at $|X_2\text{-}X_1|$, or $|X_4\text{-}X_3|$.

3.18
thermal performance measurement
test procedure which measures the temperature and humidity of the supply air when a ventilator is operating with the outside air and return air at specific psychrometric conditions

3.19
unit exhaust air transfer ratio
UEATR
tracer gas concentration difference between the supply airflow and the outdoor airflow divided by the tracer gas concentration difference between the return airflow and the outdoor airflow, at a specified airflow

Note 1 to entry: The equation for UEATR is given in 8.3.

Note 2 to entry: UEATR is expressed as a percentage.

3.20
ventilator
self contained unit that includes fans to move air through the heat/energy exchanger

3.21
energy recovery ventilator
ERV
ventilator which is designed to transfer both heat and moisture between two isolated airstreams

3.22
fresh air mass flow rate
qm_2
leaving supply mass airflow rate at station 2

3.23
heat recovery ventilator
HRV
ventilator which is designed to transfer only heat between two isolated airstreams

3.24
unducted ventilator
heat recovery ventilator or energy recovery ventilator which is not intended for connection of ducts to any of the airflow inlets or outlets except for model specific exterior termination systems as defined in 3.27

3.25
ducted ventilator
heat recovery ventilator or energy recovery ventilator which is intended for connection of ducts to one or more of the airflow inlets or outlets and intended to address a range of static pressure differentials from the duct(s)

3.26
duct
insulated or uninsulated closed passage for air that is installed as part of the ventilation system in lengths determined by the needs of application, and is separate, prior to installation from exterior terminations such as weather hoods

3.27
model-specific exterior termination system
weather hoods, fittings and through-wall penetrations designed by the ventilator manufacturer specifically for installation with a specific model of ventilator, that comprise the complete passageway connecting the ventilators outside air inlet and/or exhaust air outlet to the ventilator

3.28
net supply mass flow rate
$qm_{2,\text{net}}$
portion of the leaving supply mass airflow rate at station 2 that originated as entering supply mass flow rate at station 1, accounting for *UEATR*

Note 1 to entry: Per the equation in 8.6.1and 8.6.2.

4 Symbols and abbreviated terms

Symbol	Definition	Units
C_i	Initial tracer gas concentration in the test chamber (average of all measurement points)	
C_o	Tracer gas concentration in outdoor air (OA)	
C_{OA}	Tracer gas concentration at outdoor air inlet (station 1)	
C_p	Specific heat at supply airflow	kJ/kg K
C_{RA}	Tracer gas concentration at return air inlet (station 3)	
C_{SA}	Tracer gas concentration at supply air outlet (station 2)	
C_t	Tracer gas concentration in the test chamber after *t* hours (average of all measurement points)	
h_1	Enthalpy of the air at station 1	kJ/kg of dry air
h_2	Enthalpy of the air at station 2	kJ/kg of dry air
qm_2	Fresh air mass flow rate	kg/s
$qm_{2,\text{net}}$	Net supply mass flow rate	kg/s
NSAR	Net supply airflow ratio	%
P_{aux}	Input power to any other electrical components in the ventilator	W
P_{em}	Input power to all electric motors in the ventilator	W
P_{in}	Input power to ventilator	W
P_{vma}	Power value of moving air	J/s
Q	Gross airflow	m^3/s
Q_1	Average of the three calculated overall airflow rates with the unit under test in operation as described in B.2.1.1 and B.2.1.2	m^3/s
Q_2	Average of the three calculated natural airflow rates of the test chamber with the ventilator removed as described in B.2.2.1 and B.2.2.2	m^3/s
Q_i	Airflow rate calculated using the data from a test 'i' as described in B.2.1.1, B.2.1.2, B.2.2.1 and B.2.2.2	m^3/s
Q_{SA}	Supply airflow	m^3/s
Q_{SANet}	Net supply airflow	m^3/s
ps_n	External static pressures at the inlet(s) or outlet(s)	Pa
t	Length of time elapsed since the start of test unit operation	s
T_1	Temperature of the outdoor airflow at station 1	K
T_2	Temperature of the supply airflow at station 2	K

Symbol	Definition	Units
UEATR	Unit exhaust air transfer ratio	%
V	Air volume in the test chamber	m^3
v_s	Specific volume of the supply air	m^3/kg
x	Dry-bulb temperature (for sensible effectiveness); or absolute humidity ratio (for latent effectiveness); or total enthalpy (for total effectiveness).	°C kg water/kg dry air J/kg
ε	Effectiveness	

5 Airflow test

5.1 General conditions

All tested equipment within the scope of this International Standard shall have the airflows determined in accordance with the following provisions:

5.1.1 Temperature conditions

When measuring airflow, the laboratory ambient conditions shall be 20 ± 15 °C and 30 to 95 % RH. Laboratory ambient temperature during the test shall be recorded and reported.

5.1.2 Speed control setting

The ventilator shall be tested using the manufacturer specified speed control settings. Speed control settings shall not be adjusted during the test.

5.1.3 Unit operating voltage and frequency

The power supply voltage at the operating unit shall be within ± 2 % of the rated voltage. The power supply frequency at the operating unit shall be within ± 1 % of the rated frequency.

5.2 Ducted heat recovery ventilators and energy recovery ventilators

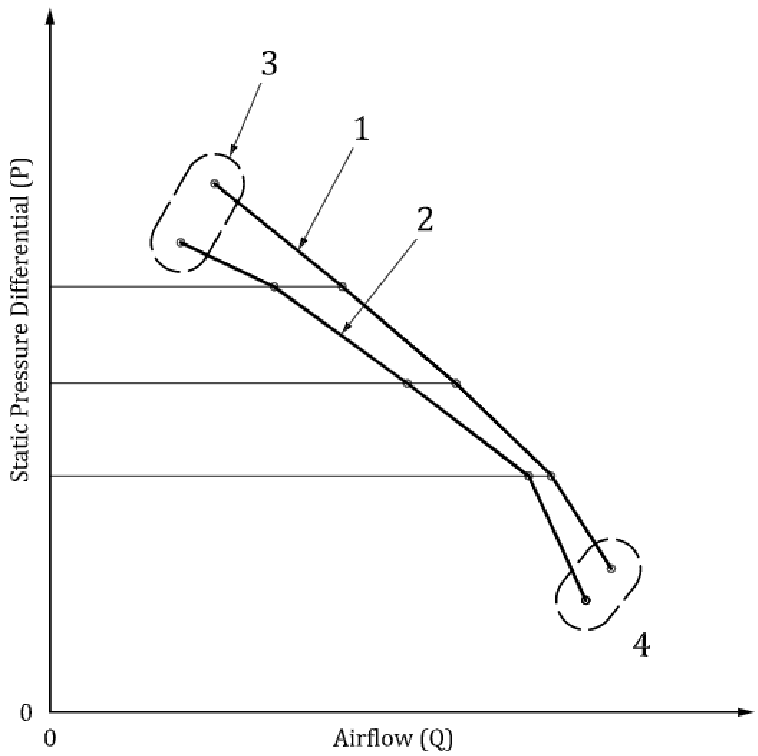
5.2.1 Airflows measured

The gross airflow shall be measured and recorded at station 2 (Supply Airflow) and at station 3 (Return Airflow) as shown in Figure 1, under the static pressure conditions indicated in 5.2.2.

5.2.2 Static pressure conditions

5.2.2.1 In order to properly characterize the performance of the unit, the ventilator shall be tested at specified maximum rated and minimum rated airflows and at a minimum of three additional, approximately evenly spaced intermediate airflows between the maximum rated airflow and minimum rated airflow. This gives a minimum of five test points as shown in Figure 2. The airflow test points must be reached by adjusting the test apparatus to change the static pressure differential. If the ventilator is equipped with a speed control device, it shall not be adjusted during this test. Input power in watts shall be measured and recorded at each test point.

5.2.2.2 Any inlet or outlet which is not designed for duct connection shall be maintained at an average value of 0 ± 2,5 Pa, static pressure for all test points. However, if the ventilator is designed for installation with model-specific exterior termination system as defined in 3.27, that system shall be installed.



Key

1 P-Q curve (supply airflow)

2 P-Q curve (return airflow)

3 minimum rated airflow

4 maximum rated airflow

Figure 2 — Representative chart of airflow performance

5.2.2.3 Static pressure measurement requirements

When testing for airflow, the requirements of 5.2.2.3 a) or 5.2.2.3 b) shall apply.

a) Only for units tested in a ducted setup:

1) For the maximum and minimum rated airflows the absolute value of static pressure at inlet (ps_1) and outlet (ps_2) shall be equal within 10 Pa or 5 %, whichever is greater, of the larger of the measured values of ps_1 or ps_2, except as noted in 5.2.2.2.

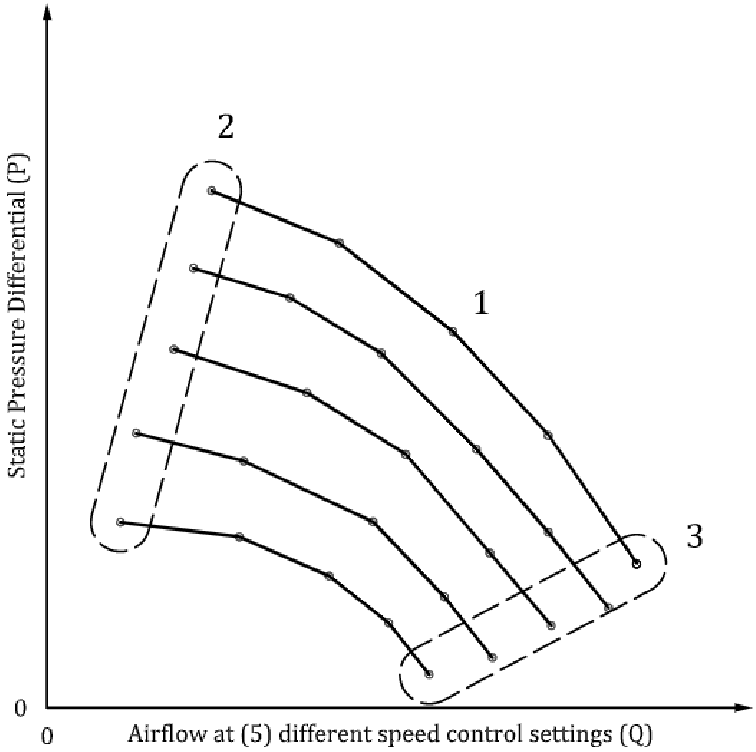
2) The absolute value of static pressure at inlet (ps_3) and outlet (ps_4) shall be equal, within 10 Pa or 5 %, whichever is greater, of the larger of the measured values of ps_3 and ps_4, except as noted in 5.2.2.2.

3) For each intermediate test point, the absolute value of static pressures at each inlet and outlet (ps_1, ps_2, ps_3 and ps_4) shall be equal within 10 Pa or 5 %, whichever is greater, of the largest of the measured value of ps_1, ps_2, ps_3 or ps_4, except as noted in 5.2.2.2.

b) Only for units tested in a two room setup:

1) For all tests the value of static pressure at inlet (ps_1) and inlet (ps_3) shall be ≤ 0 Pa, and (ps_1) and (ps_3) shall be equal within 10 Pa, or 5 %, whichever is greater, of the larger of the measured values of ps_1 or ps_3.

2) The value of static pressure at the outlets (ps_2) and (ps_4) shall be equal, within 10 Pa, or 5 %, whichever is greater, of the larger measured value of ps_2 or ps_4, except as noted in 5.2.2.2.



Key

1 P-Q curves

2 minimum rated airflows

3 maximum rated airflows

NOTE Each of the individual P-Q curves shown here is generated at a different speed control setting. In this example, the ventilator either has just five discrete speed control settings, or has a continuously-variable speed control. See 5.2.2.4. For simplification, in this example only the supply air P-Q curves are shown.

Figure 3 — Representative chart of multispeed/variable speed ventilator airflow performance

5.2.2.4 For units with speed controls, additional airflow tests must be performed at the alternate speed settings. If the speed control device setting is infinitely variable, the test as described in 5.2.2.1 shall be performed separately at a minimum of five speed control settings, including the highest and lowest speed control setting and a minimum of three additional approximately evenly spaced speed control settings between the highest and lowest settings.

5.2.2.5 If supply and return airflows cannot be measured simultaneously, static pressures at all four stations at the time of measurement of the second airflow must be equal within ± 10 Pa, or 5 % of the larger of the measured static pressures, whichever is greater, to the static pressures at the time of measurement of the first airflow.

5.2.3 Airflow measurement methods for ducted heat recovery and energy recovery ventilators

Airflow measurement methods are given in Annex A.

5.3 Unducted heat recovery ventilators and energy recovery ventilators

5.3.1 Airflows measured

The net supply airflow shall be determined. Input power, in watts, shall be measured and recorded.

5.3.2 Static pressure conditions

The effective/net airflow shall be determined with the static pressures at all inlets and outlets equal within ± 2,5 Pa.

5.3.3 Airflow measurement methods for unducted heat recovery and energy recovery ventilators

Net supply airflow measurement methods are given in Annex B for the decay method. Alternately, the net supply airflow for unducted ventilators may be measured at points 2 and 3, by the methods given in Annex A and Annex C, and the Formula in 8.4.1 provided that appropriate plenums are constructed around the inlets and outlets as indicated in Annex G. If the ventilator is designed for installation with model-specific exterior termination systems as defined in 3.18, that system shall be installed.

6 Tracer gas tests

6.1 General conditions

All heat recovery ventilators and energy recovery ventilators within the scope of this International Standard shall have the unit exhaust air transfer rate and the net supply airflow rate or net supply airflow volume determined in accordance with the provisions of this clause of this International Standard.

Tracer gas tests at other airflows and static pressure regimes may also be performed.

6.2 Temperature conditions

During tracer gas tests the laboratory ambient conditions shall be 20 ±15 °C and 30 to 95 % RH.

6.3 Preconditions

Airstreams shall be held at lab ambient temperature and humidity conditions and must remain stable for the duration of the tracer gas test. Test(s) shall be performed until tracer gas levels have stabilized.

6.4 Airflow conditions

Tracer gas testing shall be performed at the same static pressures, and at the same speed control setting used for the thermal performance measurement as required by sections 5.2.2.2, 5.2.2.3 and 5.2.2.4 in accordance with the setup type (ducted or two-room) chosen for the tracer gas testing.

6.5 Unit operating voltage and frequency

The power supply voltage at the operating unit shall be within ± 2 % of the rated voltage. The power supply frequency at the operating unit shall be within ± 1 % of the rated frequency.

6.6 Tracer gas measurement methods

Tracer gas measurement methods are given in Annex B or Annex C.

7 Determination of efficiency

7.1 General conditions

All equipment within the scope of this International Standard shall have the gross effectiveness, the coefficient of energy and the effective work determined in accordance with the provisions of this International Standard and rated at one or more of the heating and/or cooling conditions specified in Table 1 and/or Table 2.

7.2 Temperature and humidity conditions: inlets to ventilator

Tests at cooling conditions shall be carried out under the conditions given in one or more of the columns T1 through T4 in Table 1. Tests at heating conditions shall be carried out under the conditions given in one or more of the columns T5 through T7 in Table 2.

Table 1 — Conditions of test for coefficient of energy and effective work test (cooling)

Parameter		Standard test conditions			
		T1	T2	T3	T4
Temperature of outside air (°C)	dry-bulb	35			
	wet-bulb	23	24	31	24
Temperature of return air (°C)	dry-bulb	21	24	27	27
	wet-bulb	15	17	20	19
Note: Allowable variation of readings are given in Table F.2.					

Table 2 — Conditions of test for coefficient of energy and effective work test (heating)

Parameter		Standard test conditions		
		T5	T6	T7
Temperature of outside air (°C)	dry-bulb	2	5	7
	wet-bulb	1	3	6
Temperature of return air (°C)	dry-bulb	21	20	20
	wet-bulb	14	15	12
Note: Allowable variation of readings are given in Table F.2.				

7.3 Preconditions

The test room reconditioning apparatus and the equipment under test shall be operated until equilibrium conditions are attained, satisfying the tolerances given in Table F.2 over 30 continuous minutes. Capacity test data are taken during the last 15 min of this stability period.

7.4 Airflow conditions

7.4.1 Required rating point

Thermal performance measurements shall be performed at least at one rating point, maximum rated airflow at maximum fan speed.

7.4.2 Alternate rating points

Thermal performance measurements shall be performed with the supply airflow and return airflow volumes equal, within 0,0006 m^3/s plus 1 %, of the airflows measured during the airflow test. Alternately, if the thermal performance measurement equipment does not include airflow measurement devices, thermal performance measurements shall be performed with the inlet and outlet static pressures within 5 Pa or 2 %, whichever is greater, of those measured during the airflow test at the applicable rating point, and with the speed control at the same setting.

7.5 Static pressure conditions: ducted heat and energy recovery ventilators

Thermal performance measurements shall be performed with the static pressures at inlets and outlets controlled as required by sections 5.2.2.2, 5.2.2.3 and 5.2.2.4 in accordance with the setup type (ducted or two-room) chosen for the thermal performance measurements.

7.6 Static pressure conditions: unducted heat and energy recovery ventilators

The thermal performance measurements shall be performed with the static pressures at all inlets and outlets equal within ± 2,5 Pa.

7.7 Unit operating voltage and frequency

The power supply voltage at the operating unit shall be within ± 2 % of the rated voltage. The power supply frequency at the operating unit shall be within ± 1 % of the rated frequency.

7.8 Thermal performance measurement

Thermal performance measurement methods are given in Annex D.

8 Performance calculations

8.1 Performance calculations: ducted ventilators

Performance calculations for ducted ventilators are calculated based upon the average measured values taken during the testing period and shall include:

a) Unit exhaust air transfer ratio (UEATR) (See 8.3 and Annex C)

b) Net supply airflow (See 8.4.1 and Annex A)

c) Gross effectiveness (See 8.5 and Annex D)

d) Coefficient of energy (See 8.6.1 and Annex D)

e) Effective work (see 8.7.1 and Annex D)

8.2 Performance calculations: unducted ventilators

Performance calculations for unducted ventilators are calculated based upon the average measured values taken during the testing period and shall include:

a) Net supply airflow (see 8.4.2 and Annex B)

b) Gross effectiveness (See 8.5 and Annex D)

c) Coefficient of energy (See 8.6.2 and Annex D)

d) Effective work (See 8.7.2 and Annex D)

8.3 Unit Exhaust Air Transfer Ratio (UEATR)

$$\text{UEATR} = \frac{C_{\text{SA}} - C_{\text{OA}}}{C_{\text{RA}} - C_{\text{OA}}} \times 100$$

where

UEATR	is the unit exhaust air transfer ratio (%);
C_{SA}	is the tracer gas concentration at supply air outlet (station 2);
C_{OA}	is the tracer gas concentration at outdoor air inlet (station 1);
C_{RA}	is the tracer gas concentration at return air inlet (station 3).

8.4 Net supply airflow

8.4.1 Net supply airflow: ducted units

Net supply airflow for ducted units shall be calculated as follows:

$$Q_{\text{SANet}} = \frac{\text{NSAR}}{100} \times Q_{\text{SA}}$$

where

Q_{SANet}	is the net supply airflow (m^3/s);
Q_{SA}	is the supply airflow (m^3/s);
NSAR	is the net supply airflow ratio (%).

where

$$\text{NSAR} = 100 - \text{UEATR}$$

and UEATR is the unit exhaust air transfer ratio (%).

8.4.2 Net supply airflow: unducted units

Net supply airflow for unducted units as defined in Annex B shall be calculated as follows:

$$Q_{SANet} = Q_1 - Q_2$$

$$Q_i = \frac{V}{t} \ln \frac{(C_i - C_o)}{(C_t - C_o)}$$

where, when corrected to standard temperature and density:

Q_{SANet} is the net supply airflow (m^3/s);

Q_1 is the average of the three calculated overall airflow rates with the unit under test in operation as described in B.2.1.1 and B.2.1.2 (m^3/s);

Q_2 is the average of the three calculated natural airflow rates of the test chamber with the ventilator removed as described in B.2.2.1 and B.2.2.2 (m^3/s);

Q_i is the airflow rate calculated using the data from a test 'i' as described in B.2.1.1, B.2.1.2, B.2.2.1 and B.2.2.2 (m^3/s);

V is the air volume in the test chamber (m^3);

t is the length of time elapsed since the start of test unit operation (s);

C_i is the initial tracer gas concentration in the test chamber (average of all measurement points)

C_o is the tracer gas concentration in outdoor air (OA);

C_t is the tracer gas concentration in the test chamber after t seconds (average of all measurement points).

8.5 Gross effectiveness

The gross sensible, latent or total effectiveness of a HRV or ERV at test conditions is described by the following equation:

$$\varepsilon = \frac{(x_1 - x_2)}{(x_1 - x_3)}$$

where x equals one of the following for the test condition under consideration:

x is the dry-bulb temperature (for sensible effectiveness), °C; or

x is the absolute humidity ratio (for latent effectiveness), kg water/kg dry air; or

x is the total enthalpy (for total effectiveness), J/kg.

8.6 Coefficient of energy (COE)

8.6.1 Coefficient of energy: ducted ventilators

The coefficient of energy (COE) of a ducted ventilator is described by the following equation:

$$\mathrm{COE}_{\mathrm{ducted}} = \frac{\left(\left|qm_{2,\mathrm{net}}\left(h_2 - h_1\right)\right| \times 1000\right) + P_{\mathrm{vma}}}{\left(P_{\mathrm{in}}\right)}$$

where

h_1	is the enthalpy of the air at station 1 (kJ/kg of dry air);
h_2	is the enthalpy of the air at station 2 (kJ/kg of dry air);
$qm_{2,\mathrm{net}}$	is the net supply mass flow rate at station 2 (kg/s);
P_{vma}	is the power value of moving air (J/s);
P_{in}	is the input power to ventilator (W).

and

$$qm_{2,\mathrm{net}} = qm_2\left(1 - \frac{\mathrm{UEATR}}{100}\right)$$

and

$$P_{\mathrm{vma}} = \left(\sum_{n=1}^{4}\left|ps_{\mathrm{n}} + pv_{\mathrm{n}}\right|\right) 2qm_{2,\mathrm{net}} v_{\mathrm{s}}$$

where

v_{s}	is the specific volume of the supply air (m^3/kg);
ps_{n}	is the external static pressures at the inlet(s) and outlet(s) (Pa);
pv_{n}	is the dynamic pressure at the inlet(s) and outlet(s) (Pa).

and

$$P_{\mathrm{in}} = P_{\mathrm{em}} + P_{\mathrm{aux}}$$

where

P_{em}	is the input power to all electric motors in the ventilator (W);
P_{aux}	is the input power to any other electrical components in the ventilator (W).

8.6.2 Coefficient of energy: unducted ventilators

The coefficient of energy (COE) of an unducted ventilator is described by the following equation

$$\mathrm{COE}_{\mathrm{unducted}} = \frac{\left| qm_{2,\mathrm{net}} \left(h_2 - h_1 \right) \right| \times 1000}{\left(P_{\mathrm{in}} \right)}$$

where

h_1	is the enthalpy of the air at station 1 (kJ/kg of dry air);
h_2	is the enthalpy of the air at station 2 (kJ/kg of dry air);
$qm_{2,\mathrm{net}}$	is the net supply mass flow rate (kg/s);
P_{in}	is the input power to ventilator (W).

and

$$qm_{2,\mathrm{net}} = qm_2 \left(1 - \frac{\mathrm{UEATR}}{100} \right)$$

and

$$P_{\mathrm{in}} = P_{\mathrm{em}} + P_{\mathrm{aux}}$$

where

P_{em}	is the input power to all electric motors in the ventilator (W);
P_{aux}	is the input power to any other electrical components in the ventilator (W).

8.7 Effective work (EW)

8.7.1 Effective work: ducted ventilators

The effective work (EW) of a ducted ventilator is described by the following equation:

$$\mathrm{EW} = P_{\mathrm{in}} \times \left(\mathrm{COE}_{\mathrm{ducted}} - 1 \right) = \left(\left| qm_{2,\mathrm{net}} \left(h_2 - h_1 \right) \right| \times 1000 \right) + P_{\mathrm{vma}} - P_{\mathrm{in}}$$

8.7.2 Effective work: unducted ventilators

The effective work (EW) of an unducted ventilator is described by the following equation:

$$\mathrm{EW}_{\mathrm{unducted}} = P_{\mathrm{in}} \times \left(\mathrm{COE}_{\mathrm{unducted}} - 1 \right) = \left(\left| qm_{2,\mathrm{net}} \left(h_2 - h_1 \right) \right| \times 1000 \right) - P_{\mathrm{in}}$$

8.7.3 When moisture transfer is not of interest or does not occur: the following substitution can be made in either COE or EW:

$$\left|h_2 - h_1\right| = C_{\mathrm{p}}\left|T_2 - T_1\right|$$

or

$$\left|h_2 - h_1\right| = \left|C_{\mathrm{p}2} \cdot T_2 - C_{\mathrm{p}1} \cdot T_1\right|$$

where

C_{p} is the specific heat at supply airflow (kJ/kg K);

T_1 is the temperature of the outdoor airflow at station 1 (K);

T_2 is the temperature of the supply airflow at station 2 (K).

9 Test results

All measurements made under this standard need to be reported together in order to accurately characterize ventilator performance. Sample data collection and reporting worksheets are provided in informative Annex E.

Annex A
(normative)

Airflow measurement method for both ducted and unducted ventilators

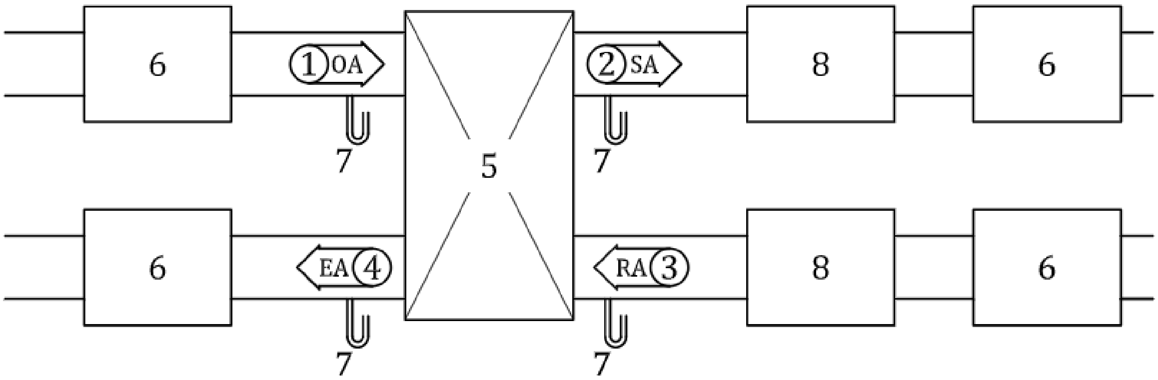
A.1 Test equipment

A.1.1 Unit shall be equipped with ductwork, airflow measurement devices, and pressure balancing means as shown in Figure A.1.

A.1.2 Static pressure controllers shall be provided as necessary to balance the static pressures at the inlets and outlets as prescribed. Static pressure controllers may include dampers and or speed-controllable blowers. The static pressure controllers must be air tight if they are located between the ventilator and the airflow measuring apparatus.

A.1.3 Static pressure measurement devices shall be located so as to accurately characterize the static pressures at the inlets and outlets of the ventilator. Appropriate measurement devices are further defined in ISO 3966, ISO 5167-1, and ISO 5801.

A.1.4 The airflow shall be measured according to ISO 3966, ISO 5167-1, ISO 5221 and ISO 5801 shall be expressed in standard m^3/s.



Key

1	outdoor airflow
2	supply airflow
3	return airflow
4	exhaust airflow
5	ventilator
6	static pressure control apparatus

7 static pressure measuring apparatus

8 airflow measuring apparatus

NOTE Simultaneous measurement of supply and return airflow is preferred; however, at least one airflow measuring apparatus must be in use as per 5.2.2.5.

Figure A.1 — Arrangement for airflow measurement

Figure A.1 shows the basic measurement principle.

Annex B
(normative)

Decay method for measurement of net supply airflow

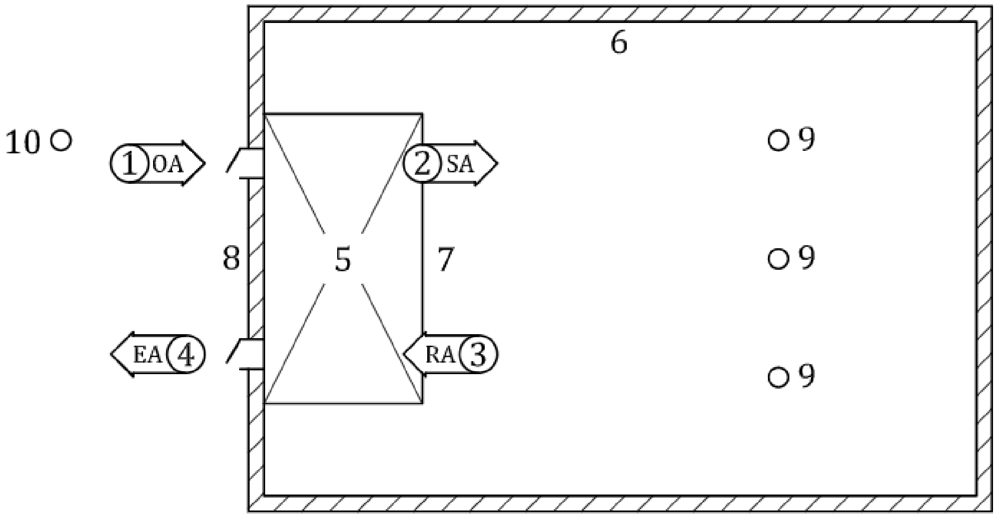
B.1 Measurement equipment

B.1.1 Tracer gas, sampling equipment, room volume and gas concentration levels shall be selected so as to be capable of accurately measuring the unit performance.

B.1.2 Three sampling pipes shall be installed inside the test chamber, in three vertical positions around the centre of the chamber.

B.1.3 The inner wall material of the test chamber shall not be gas permeable or gas absorbent.

B.1.4 The air tightness of the test chamber shall be 0,3 or less natural air change per hour.



Key

1	outdoor airflow (OA) (entering)
2	supply airflow (SA) (leaving)
3	return air (RA) (entering)
4	exhaust air (EA) (leaving)
5	ventilator
6	test chamber
7	indoor side
8	outdoor side
9	indoor sampling pipes
10	outdoor sampling pipes

Figure B.1 — Basic measurement principle for sample measurement equipment setup (decay method) for net supply airflow measurement of unducted units

B.2 Measurement procedure

Tracer gas concentration measurement shall be as follows:

B.2.1 Determination of overall room air change rate with ventilator in operation: Install the ventilator, complete with all model-specific exterior termination systems and/or grilles, as shown in Figure B.1.

B.2.1.1 Measurement of initial concentration of tracer gas: Fill the test chamber with the tracer gas, and verify that the concentration level is uniform throughout the chamber by measuring the concentration in at least three locations. The ventilator shall not be operating. The tracer gas concentration shall be such that tracer gas will be measurable after 30 min of operation of the unit under test.

B.2.1.2 Measurement of concentrations of tracer gas during the test: The ventilator shall be started at time zero. Measure and record the concentration of tracer gas at time zero, 10 min, 20 min and 30 min after the start of the test.

B.2.1.3 The test as described in B.2.1.1 and B.2.1.2 shall be performed three times.

B.2.2 Determination of natural air change rate with ventilator not in operation. Remove the test unit, and seal the unit installation opening.

B.2.2.1 Measurement of initial concentration of tracer gas: Fill the test chamber with the tracer gas, and verify that the concentration level is uniform throughout the chamber by measuring the concentration in at least three locations. The tracer gas concentration shall be such that tracer gas will be measurable after 30 min of natural ventilation of the chamber.

B.2.2.2 Measurement of concentrations of tracer gas during the test: Measure and record the concentration of tracer gas at time zero, 10 min, 20 min and 30 min after the start of the test.

B.2.2.3 The test as described in B.2.2.1 and B.2.2.2 shall be performed three times.

Annex C
(normative)

Unit exhaust air transfer ratio measurement methods

C.1 Test equipment

Unit shall be equipped with ductwork, and static pressure controllers. Tracer gas, sampling equipment, room volume and gas concentration levels shall be selected so as to be capable of accurately measuring the unit internal and external leakages.

All test equipment arrangements can be divided into two categories: ducted test facilities and two-room test facilities.

C.1.1 The tracer gas generation equipment shall be designed to provide a stable concentration of tracer gas that is uniform in the chamber or duct to which the tracer gas is introduced.

C.1.2 Measurement equipment shall be provided at each location where tracer gas concentration must be measured such that:

1. tracer gas concentration readings are taken at a minimum of three representative locations or

2. by a means of collecting and transporting air samples from these multiple locations to the analyser (i.e. a sampling grid).

This equipment shall meet the following requirements (mixing devices may be necessary to meet these requirements):

a) a gas chromatograph analyser or an alternative instrument with the accuracy required by Annex F; if the analyser will be sequentially measuring the tracer gas concentration in samples from more than one of the stations, then either the data or the sample from the beginning of each sample measurement period should be purged until the concentration readings have stabilized;

b) a means of injecting a tracer gas that is nontoxic, identifiable, measureable and inert. Common tracer gases include, but are not limited to SF_6 and CO_2; and

c) the tracer gas concentrations at each sample point shall be within ± 5 % of the mean when taken simultaneously or within ± 2 % of the mean if taken at different times.

C.1.3 Ducts and other components of the test equipment shall not be permeable to or absorbent of the tracer gas.

C.1.4 Ducts and other components of the test equipment shall not allow air leakage.

C.1.5 Static pressures shall be measured according to ISO 3966, ISO 5167-1, and ISO 5801.

C.2 General procedures

C.2.1 Extreme care shall be taken to ensure that dilution does not occur in the sampling system.

C.2.2 The injection concentration of the tracer gas shall be sufficient that a unit exhaust air transfer ratio of 0,25 % can be measured by the device being used.

C.3 Procedure for ventilators intended for installation in a conditioned space

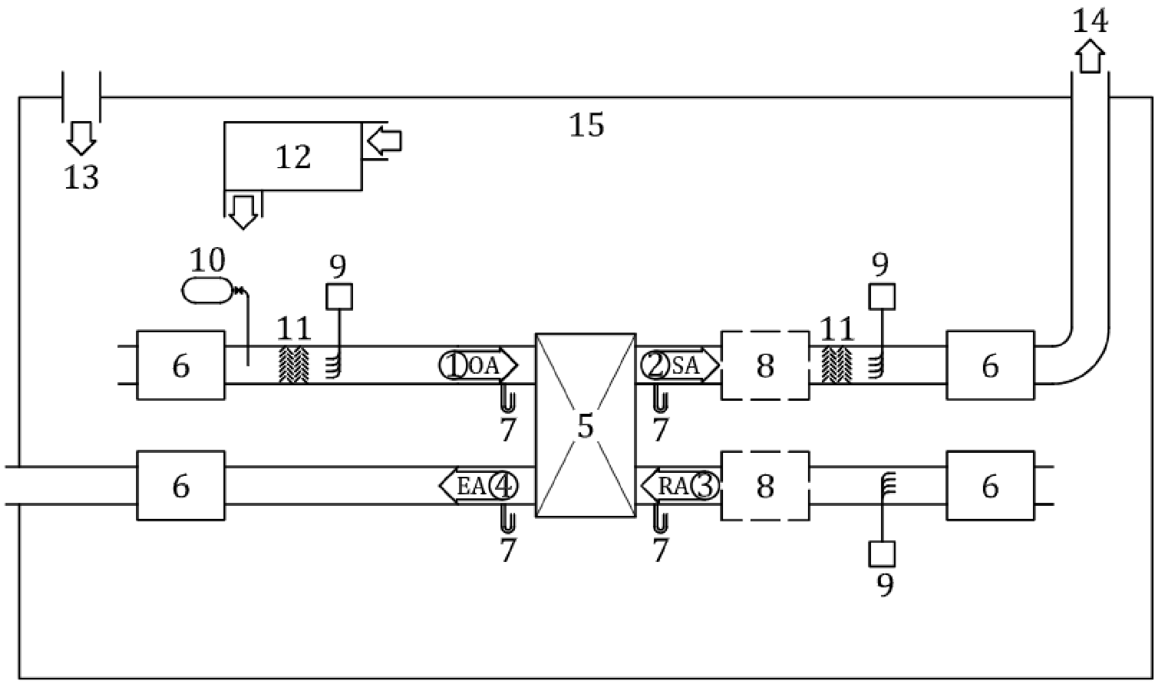
These tests determine the total amount of leakage inside the unit from the return air (x_3) to the fresh air (x_2) and from the surrounding room to the fresh air (x_2).

C.3.1 Testing by injection of tracer gas into outside air (OA)

C.3.1.1 A tracer gas shall be injected into a turbulent region upstream of Station 1 (see Figure C.1).

C.3.1.2 Air samples shall be drawn from Stations 1, 2 and 3 to determine the concentration of the tracer gas.

C.3.1.3 Unit exhaust air transfer ratio shall be determined.



Key

1	outdoor airflow	9	tracer gas sampler
2	supply airflow	10	tracer gas source
3	return airflow	11	air mixer
4	exhaust airflow	12	air conditioning apparatus
5	ventilator	13	make up air inlet
6	static pressure control apparatus	14	supply air outlet
7	static pressure measuring apparatus	15	test facility
8	airflow measuring apparatus		

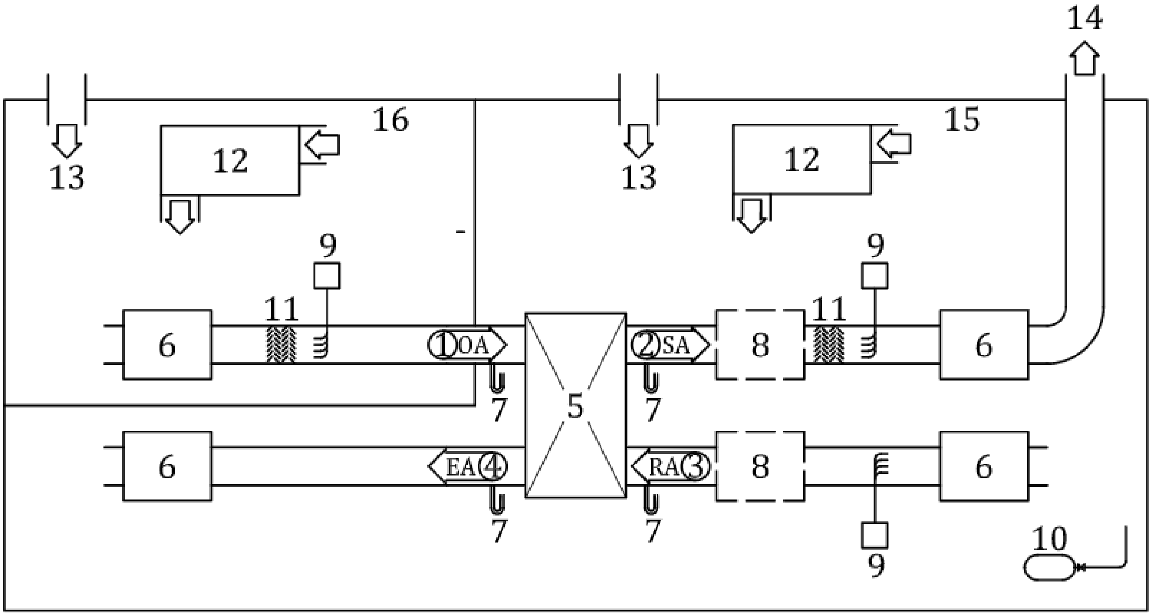
Figure C.1 — Basic measurement principle schematic for ducted UEATR measurement system for ventilators intended for installation in a conditioned space

C.3.2 Testing by tracer gas injected into indoor chamber

C.3.2.1 A tracer gas shall be injected into the inside room (see Figure C.2).

C.3.2.2 Air samples shall be drawn from Stations 1, 2 and 3 to determine the concentration of the tracer gas.

C.3.2.3 Unit exhaust air transfer ratio (UEATR) shall be determined.



Key

1	outdoor airflow	9	tracer gas sampler
2	supply airflow	10	tracer gas source
3	return airflow	11	air mixer
4	exhaust airflow	12	air conditioning apparatus
5	ventilator	13	make up air inlet
6	static pressure control apparatus	14	supply air outlet
7	static pressure measuring apparatus	15	“indoor” test facility
8	airflow measuring apparatus	16	“outdoor” test facility

Figure C.2 — Basic measurement principle schematic for two-room UEATR measurement system for ventilators intended for installation in a conditioned space, with tracer gas introduced into “Indoor” chamber

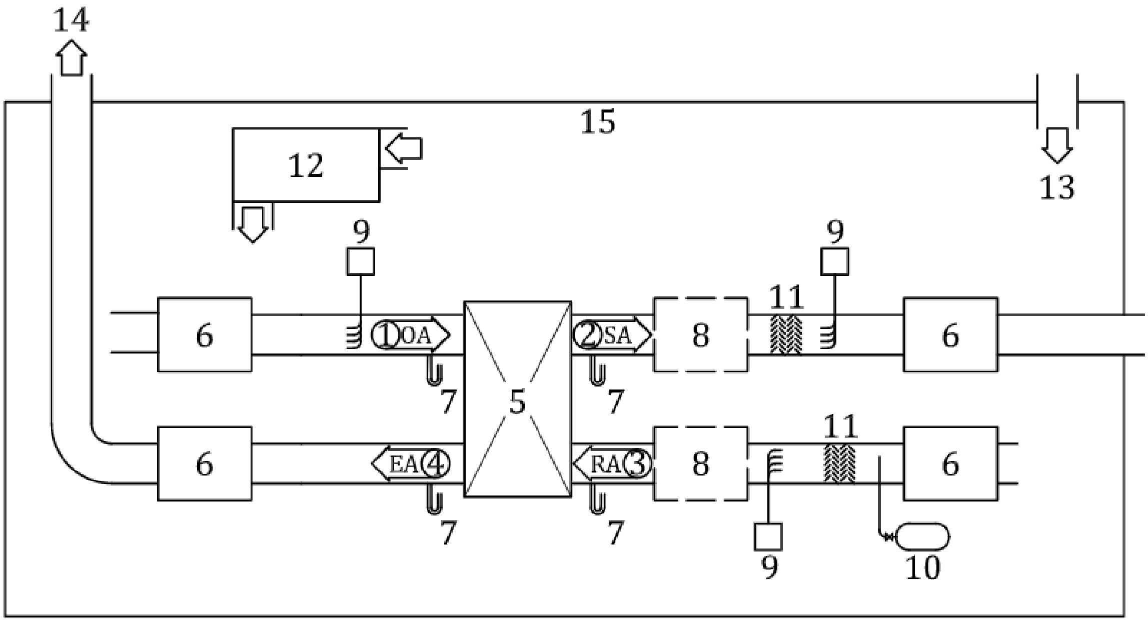
C.4 Procedure for ventilators intended for installation in outdoors space

This test determines the amount of leakage inside the unit from the return air to the fresh air.

C.4.1 A tracer gas shall be injected a turbulent region upstream of Station 3 or into the inside room.

C.4.2 Air samples shall be drawn from Stations 1, 2, and 3 to determine the concentration of the tracer gas (see Figure C.3).

C.4.3 Unit exhaust air transfer ratio shall be determined.



Key

1 outdoor airflow
2 supply airflow
3 return airflow
4 exhaust airflow
5 ventilator
6 static pressure control apparatus
7 static pressure measuring apparatus
8 airflow measuring apparatus
9 tracer gas sampler
10 tracer gas source
11 air mixer
12 air conditioning apparatus
13 make up air inlet
14 supply air outlet
15 test facility

Figure C.3 — Basic measurement principle schematic for ducted UEATR measurement system for ventilators intended for installation outdoors

Annex D
(normative)

Thermal performance measurement

D.1 Test equipment

D.1.1 When measuring thermal performance as per Figure D.1, the laboratory ambient conditions shall be 20 ± 10 ° C and 30 to 95 % RH. Laboratory ambient temperature during the test shall be recorded and reported.

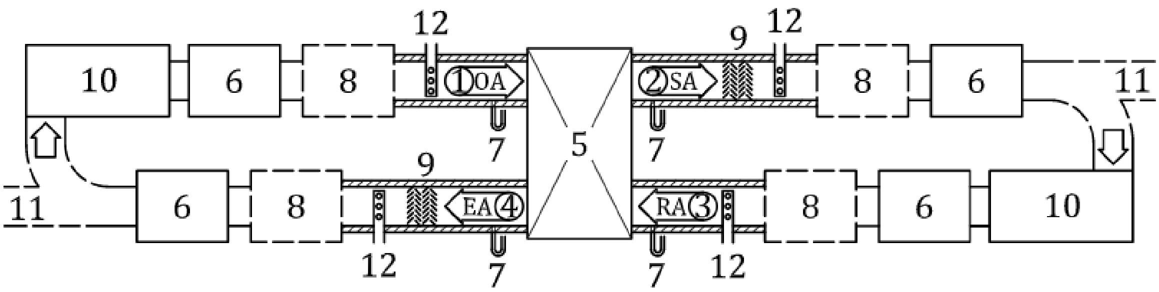
D.1.2 Unit shall be equipped with ductwork, static pressure measurement devices, and pressure balancing means as shown in schematic Figures D.1, D.2 and D.3. Temperature and humidity at all the measurement stations shall be recorded during the testing period at a rate of not less than once per minute. Once the unit is at steady-state, operation, including preconditioning as per 6.3, shall continue until at least 30 measurements have been recorded over a period of at least 15 min. Construction of plenums required to connect these devices to unducted inlets or outlets is described in D.2. Informative Annex G shows an example of plenum construction.

D.1.3 Static pressures shall be measured according to ISO 3966, ISO 5167-1, and ISO 5801.

D.1.4 Airflow shall be measured according to ISO 3966, ISO 5167-1, and ISO 5801 and shall be expressed in standard m^3/s.

D.1.5 Ducts connected to ventilator inlets and outlets shall be of the dimensions specified by the manufacturer.

D.1.6 The ducts shall be thermally insulated to minimize heat leakage between the equipment inlet or outlet and the temperature measuring instruments, so that the test results are not changed by the effects of surrounding temperatures.



Key

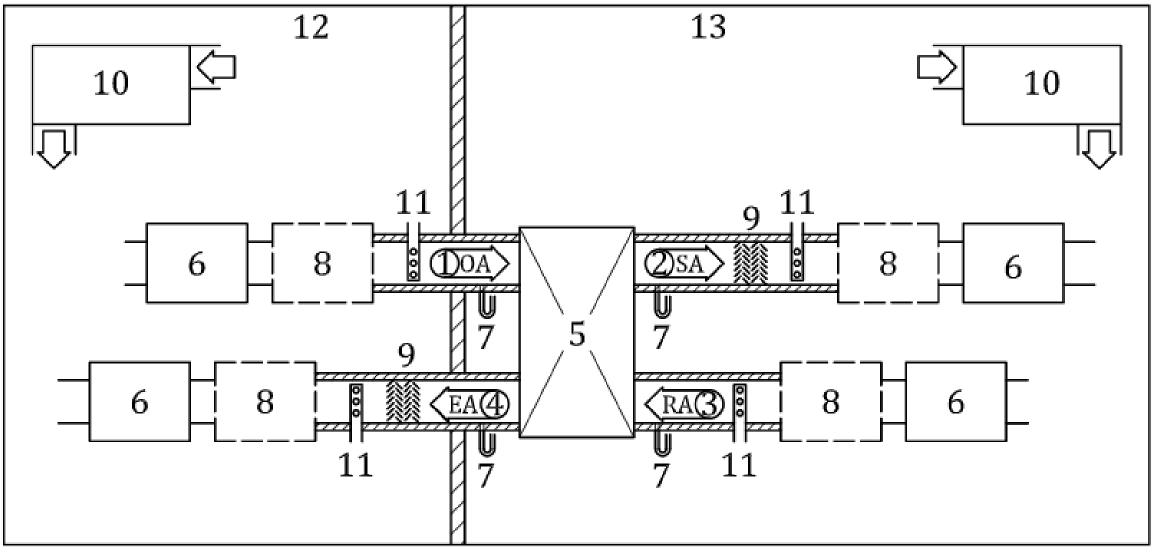
1 outdoor airflow
2 supply airflow
3 return airflow
4 exhaust airflow
5 ventilator
6 static pressure control apparatus
9 air mixer
10 air conditioning apparatus
11 relief inlet/outlet
12 temperature and humidity measuring instrument
15 test facility

7 static pressure measuring apparatus

8 airflow measuring apparatus

NOTE Airflow measurement devices are optional. Temperature and humidity measurement and mixing station at EA are optional.

Figure D.1 — Basic measurement principle schematic for ducted thermal performance measurement setup



Key

1 outdoor airflow

2 supply airflow

3 return airflow

4 exhaust airflow

5 ventilator

6 static pressure control apparatus

7 static pressure measuring apparatus

8 airflow measuring apparatus

9 air mixer

10 air conditioning apparatus

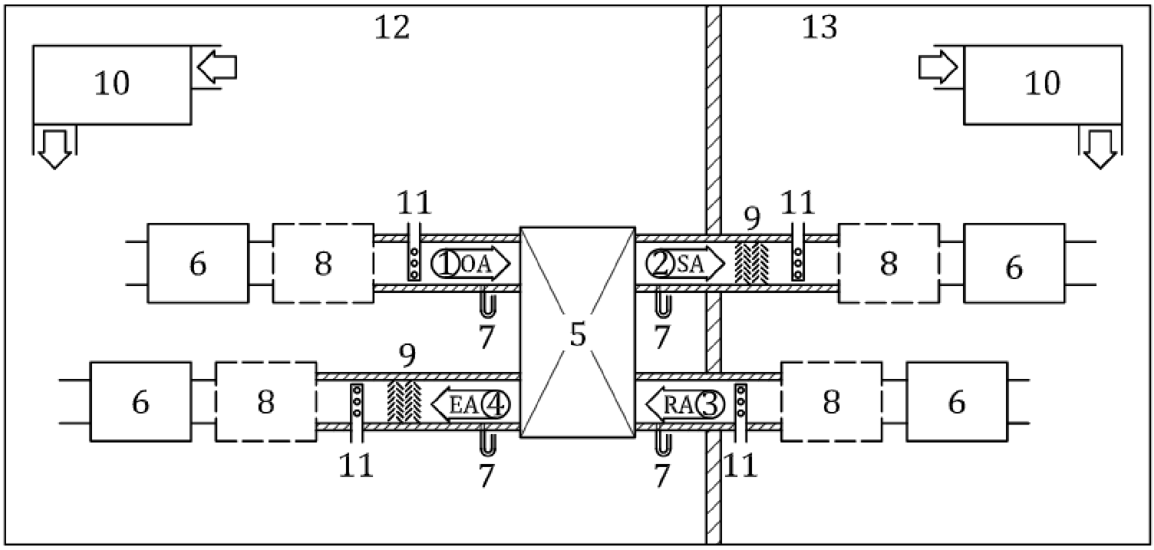
11 temperature and humidity measuring instrument

12 “outdoor” test facility

13 “indoor” test facility

NOTE Airflow measurement devices (not shown) are optional. Mixing station and temperature and humidity measurement at EA are optional.

Figure D.2 — Basic measurement principle schematic for two-room thermal performance measurement for ventilators intended for installation in a conditioned space



Key

1 outdoor airflow
2 supply airflow
3 return airflow
4 exhaust airflow
5 ventilator
6 static pressure control apparatus
7 static pressure measuring apparatus
8 airflow measuring apparatus
9 air mixer
10 air conditioning apparatus
11 temperature and humidity measuring instrument
12 “outdoor” test facility
13 “indoor” test facility

NOTE Airflow measurement devices are optional. Mixing station and temperature and humidity measurement at EA are optional.

Figure D.3 — Basic measurement principle schematic for two-room thermal performance measurement for ventilators intended for installation outside

D.2 Test performance

D.2.1 Verify that the difference between the highest and the lowest temperatures inside the duct at the temperature measurement location will not be more than 0,3K. Provide a mixing device upstream of the temperature measurement location if necessary to meet this requirement.

Annex E
(informative)

Example data collection and reporting sheets

DATA TO BE COLLECTED AND CALCULATED RESULTS FOR AIRFLOW MEASUREMENT per Annex A

		AIRFLOW PERFORMANCE: DATA COLLECTED NOTE 1					
		Point 1 (Max)	Point 2	Point 3	Point 4	Point 5 (Min)	Units
Temperature (Dry bulb) NOTE 2	T_2 NOTE 3						(°C)
	T_3						(°C)
Temperature (Wet bulb)	TW_2						(°C)
	TW_3						(°C)
Barometric pressure, Lab Ambient	P_{bar}						(kPa)
Static Pressures NOTE 4	ps_1						(Pa)
	ps_2						(Pa)
	ps_3						(Pa)
	ps_4						(Pa)
Delta P at Nozzles, or Velocity Pressures NOTE 5	ΔP_2						(Pa)
	ΔP_3						(Pa)
Static Pressures Before Nozzles NOTE 5	psN_2						(Pa)
	psN_3						(Pa)
Input Voltage NOTE 6	V						(V)
Input Power	W						(W)
Input Current	A						(A)
Input Frequency NOTE 6	f						(Hz)
Speed Control Setting NOTE 7	-						()

NOTE 1 Point 1 is the Maximum Rated Airflow. Point 5 is the Minimum Rated Airflow. If the unit has multiple Speed Control Settings, the Airflow Performance Test is repeated to characterize unit airflow at the different Speed Control Settings.

NOTE 2 Psychrometric conditions are measured in order to determine mass flow rates and equivalent volumetric flow rates at standard density.

NOTE 3 Subscripts indicate station(s) at which measurements are taken.

NOTE 4 Measured relative to lab atmospheric pressure. Static pressures are to be controlled within specific tolerances.

NOTE 5 Depending on the method of airflow measurement, other data might need to be collected.

NOTE 6 To be controlled within tolerances.

NOTE 7 Speed is not measured. Control Setting (if any) is recorded.

		AIRFLOW PERFORMANCE: CALCULATED RESULTS NOTE 8					
		Point 1 (Max)	Point 2	Point 3	Point 4	Point 5 (Min)	Units
Supply Airflow	Q_{SA}						(m^3/s)
Return Airflow	Q_3						(m^3/s)
Static Pressure Differentials	$ps_{\|2-1\|}$						(Pa)
	$ps_{\|4-3\|}$						(Pa)

NOTE 8 Point 1 is the Maximum Rated Airflow. Point 5 is the Minimum Rated Airflow

DATA TO BE COLLECTED AND CALCULATED RESULTS FOR NET SUPPLY AIRFLOW MEASUREMENT BY DECAY METHOD per Annex B

		DATA COLLECTED WITH VENTILATOR RUNNING NOTE 9			
		Test 1 NOTE 10	Test 2	Test 3	Units
Ambient Temperature (Dry bulb) NOTE 11	T_a				(°C)
Ambient Temperature (Wet bulb)	TW_a				(°C)
Barometric pressure, Lab Ambient	$P_{bar,a}$				(kPa)
Barometric pressure, Chamber	$P_{bar,c}$				(kPa)
Tracer Gas Concentration in Chamber "Ci @ t_n" NOTE 12	C_i @ t_0				(ppm)
	C_i @ t_{10}				(ppm)
	C_i @ t_{20}				(ppm)
	C_i @ t_{30}				(ppm)
Tracer Gas Concentration in Outdoor Air "Co @ t_n"	C_o @ t_0				(ppm)
	C_o @ t_{10}				(ppm)
	C_o @ t_{20}				(ppm)
	C_o @ t_{30}				(ppm)
Input Voltage NOTE 13	V				(V)
Input Power	W				(W)
Input Current	A				(A)
Input Frequency NOTE 13	f				(Hz)
Speed Control Setting NOTE 14	-				()

NOTE 9 If the unit has multiple Speed Control Settings, the Airflow Performance Test is repeated to characterize unit airflow at the different Speed Control Settings.

NOTE 10 For any one Speed Control Setting, the Test Procedure is repeated three times.

NOTE 11 Psychrometric conditions are measured in order to determine mass flow rates and equivalent volumetric flow rates at standard density.

NOTE 12 Subscript n indicates the time in minutes after beginning the test at which the measurement is taken.

Note 13 To be controlled within tolerances.

Note 14 Speed is not measured. Control Setting (if any) is recorded.

		DATA COLLECTED WITH VENTILATOR REMOVED			
		Test 1 NOTE 15	Test 2	Test 3	Units
Ambient Temperature (Dry bulb) NOTE 16	T_a				(°C)
Ambient Temperature (Wet bulb)	TW_a				(°C)
Barometric pressure, Lab Ambient	$P_{bar,a}$				(kPa)
Barometric pressure, Chamber	$P_{bar,c}$				(kPa)
Tracer Gas Concentration in Chamber "Ci @ t_n" NOTE 17	C_i @ t_0				(ppm)
	C_i @ t_{10}				(ppm)
	C_i @ t_{20}				(ppm)
	C_i @ t_{30}				(ppm)
Tracer Gas Concentration in Outdoor Air "Co @ t_n"	C_o @ t_0				(ppm)
	C_o @ t_{10}				(ppm)
	C_o @ t_{20}				(ppm)
	C_o @ t_{30}				(ppm)
Chamber Volume	V				(m^3)

NOTE 15 With the ventilator removed, the Test Procedure is repeated three times.

NOTE 16 Psychrometric conditions are measured in order to determine mass flow rates and equivalent volumetric flow rates at standard density.

NOTE 17 Subscript n indicates the time in minutes after beginning the test at which the measurement is taken.

		NET SUPPLY AIRFLOW: CALCULATED RESULTS					
		Point 1 (Max)	Point 2	Point 3	Point 4	Point 5 (Min)	Units
Net Supply Airflow NOTE 18	Q_{SANet}						(m^3/s)

Note 18 Calculated per 8.4.2.

DATA TO BE COLLECTED AND CALCULATED RESULTS FOR UEATR MEASUREMENT per Annex C

		TRACER GAS TEST: DATA COLLECTED NOTE 19					
		Test 1	Test 2	Test 3	Test 4	Test 5	Units
Static Pressures NOTE 20	ps_1 NOTE 21						(Pa)
	ps_2						(Pa)
	ps_3						(Pa)
	ps_4						(Pa)
Tracer Gas Concentration NOTE 22	C_{in}						(ppm)
	C_{out}						(ppm)
	C_{back}						(ppm)
Barometric pressure, Lab Ambient, average NOTE 23	$P_{bar,AVE}$						(kPa)
Barometric pressure, Lab Ambient, maximum NOTE 23	$P_{bar,MAX}$						(kPa)
Temperature, Lab Ambient, average NOTE 23	T_1 NOTE 20						(°C)
Temperature, Lab Ambient, maximum NOTE 23	T_1 NOTE 20						(°C)
Speed Control Setting NOTE 24	-						()

NOTE 19 The unit must be tested for EATR at each of the same static pressures and speed control settings at which the Thermal Performance tests were performed. Static pressures are to be controlled to within specific tolerances.

NOTE 20 Measured relative to lab atmospheric pressure. Static pressures are to be controlled within specific tolerances.

NOTE 21 Subscripts indicate station(s) at which measurements are taken.

NOTE 22 Locations of C_{in}, C_{out}, and C_{back} depend on intended installation type: indoor, rooftop, or thru-wall.

NOTE 23 Measured and recorded only to confirm stability of conditions during test.

NOTE 24 Speed is not measured. Control Setting (if any) is recorded.

		TRACER GAS TEST: CALCULATED RESULTS					
		Test 1	Test 2	Test 3	Test 4	Test 5	Units
Unit Exhaust Air Transfer Ratio NOTE 25	UEATR						(%)

NOTE 25 Calculated per 8.3.

DATA TO BE COLLECTED AND CALCULATED RESULTS FOR EFFICIENCY MEASUREMENTS per Annex D

		THERMAL PERFORMANCE: DATA COLLECTED NOTE 26					
		Test 1	Test 2	Test 3	Test 4	Test 5	Units
Temperature (Dry bulb)	T_1 NOTE 27						(°C)
	T_2						(°C)
	T_3						(°C)
Temperature (Wet bulb)	TW_1						(°C)
	TW_2						(°C)
	TW_3						(°C)

		THERMAL PERFORMANCE: DATA COLLECTED NOTE 26					
		Test 1	Test 2	Test 3	Test 4	Test 5	Units
Barometric pressure, Lab Ambient	P_{bar}						(kPa)
Static Pressures NOTE 28	ps_1						(Pa)
	ps_2						(Pa)
	ps_3						(Pa)
	ps_4						(Pa)
Delta P at Nozzles, or Velocity Pressures NOTE 29	ΔP_2						(Pa)
	ΔP_3						(Pa)
Static Pressures Before Nozzles NOTE 29	psN_2						(Pa)
	psN_3						(Pa)
Input Voltage NOTE 30	V						(V)
Input Power	W						(W)
Input Current	A						(A)
Input Frequency NOTE 30	f						(Hz)
Speed Control Setting NOTE 31	-						()

NOTE 26 At least one thermal test is performed at the maximum rated airflow at maximum speed control setting. Additional thermal tests may be performed at other rated airflows and speed control settings.

NOTE 27 Subscripts indicate station(s) at which measurements are taken.

NOTE 28 Measured relative to lab atmospheric pressure. Static pressures are to be controlled within specific tolerances.

NOTE 29 Depending on the method of airflow measurement, other data might need to be collected.

NOTE 30 To be controlled within tolerances.

NOTE 31 Speed is not measured. Control Setting (if any) is recorded.

		THERMAL PERFORMANCE: CALCULATED RESULTS					
		Test 1	Test 2	Test 3	Test 4	Test 5	Units
Gross Effectiveness, Sensible, Latent or Total	ε_{gross} NOTE 32						(%)
Supply Airflow	Q_{SA}						(m³/s)
Return Airflow	Q_3						(m³/s)
Static Pressure Differentials	$ps_{\|2-1\|}$						(Pa)
	$ps_{\|4-3\|}$						(Pa)

NOTE 32 Calculated per 8.5.

CALCULATED RESULTS FOR COE, EW and Net supply airflow

		ENERGY METRICS and OTHER RESULTS					
		Test 1	Test 2	Test 3	Test 4	Test 5	Units
Net Supply Airflow NOTE 33	Q_{SANet}						(m³/s)
Coefficient of Energy NOTE 34	COE						()
Effective Work NOTE 35	EW_n						(W)

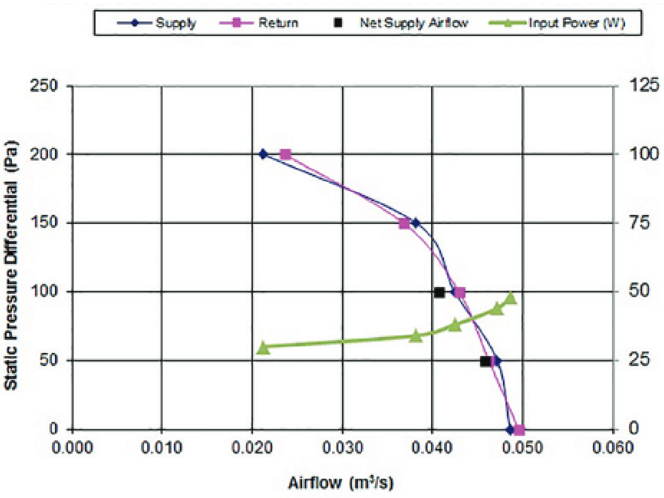
NOTE 33 Calculated per 8.4.

NOTE 34 Calculated per 8.6.

NOTE 35 Calculated per 8.7.

Model	PlentyAire 100	Intended Installation Location:		
Manufacturer	EveryERV Company	☑Indoors	☐ Outdoors	☐ Thru-wall
Testing Body	Erewhon Testing Institute			

Ventilation Performance						Note: Expand Ventilation Table as necessary to provide additional ratings if desired, such as at different Speed Control Settings.
Static Pressure Differential (Pa)	Gross Airflow (m³/s)		Net Supply Airflow (m³/s)	Input Power (W)	Speed	
	Supply	Return				
0	0,029	0,029	-	50	HIGH	
50	0,028	0,027	0,027	44		
100	0,025	0,025	0,024	38		
150	0,023	0,022	-	34		
200	0,013	0,014	-	30		



Tested with ducts connected to:	
☑ OA	☑ SA
☑ RA	☑ EA

Unit intended for installation with ducts connected to:	
☑ OA	☑ SA
☑ RA	☑ EA

Unit Exhaust Air Transfer Performance		
Static Pressure Differential (Pa)	UEATR	Speed
0	-	HIGH
50	3%	
100	4%	
150	-	
200	-	

Note: Expand UEATR Table as necessary to provide all UEATR ratings used in calculation of Net Supply Airflow, COE and EW.

EFFECTIVENESS							
Conditions (°C)	Gross Airflows (m³/s)		Speed	Input Power (W)	Gross Effectiveness		
	Supply	Return			Sensible	Latent	Total
Standard Summer Conditions: Outside Air 35DB/24WB Room Air 24DB/17WB	0,028	0,027	HIGH	44	68 %	55 %	60 %
	0,025	0,025	HIGH	38	70 %	57 %	62 %
	-	-	-	-	-	-	-
Standard Winter Conditions: Outside Air 2DB/1WB Room Air 21DB/14WB	0,028	0,027	HIGH	44	68 %	55 %	64 %
	0,025	0,025	HIGH	38	70 %	57 %	66 %
	-	-	-	-	-	-	-
Note: Expand EFFECTIVENESS Table as necessary to provide ratings at optional operating points.							

ENERGY METRICS					
Conditions	Net Supply Airflow (m^3/s)	Speed	Input Power (W)	COE ()	EW (W)
Summer: Outside Air 35DB/24WB Room Air 24DB/17WB	0,027	HIGH	44	8,94	349
	0,024	HIGH	38	9,58	326
	-	-	-	-	-
Winter: Outside Air 2DB/1WB Room Air 21DB/14WB	0,027	HIGH	44	10,95	438
	0,024	HIGH	38	11,69	406
	-	-	-	-	-

Annex F
(normative)

Required instrument uncertainty

Table F.1 — Uncertainties of measurements

Measured quantity	Uncertainty of measurement[a]
Air: dry-bulb temperature wet-bulb temperature[b]	 0,2 °C 0,2 °C
Air static pressure	5 Pa for pressure ≤ 100 Pa 5 % for pressure > 100 Pa 1 Pa at zero
Air volume flow	5 %
Electrical inputs Voltage, Amperage, Watts, Frequency	1,0 %
Time	0,2 %
Mass	1,0 %
Tracer gas concentration	5,0 %

NOTE Uncertainty of measurement comprises, in general, many components. Some of these components may be estimated on the basis of the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. Estimates of other components can be based on experience or other information.

a) Uncertainty of measurement is an estimate characterizing the range of values within which the true value of the measurement lies, based on a 95 % confidence interval (see ISO/IEC Guide 98-3).

b) Can be measured directly or calculated indirectly from dew point or relative humidity

Table F.2 — Variations allowed during tests

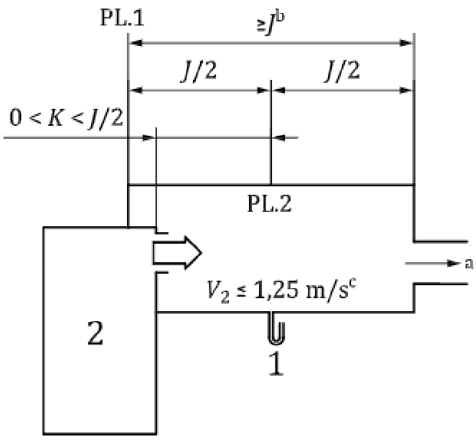
Readings	Variations of arithmetical mean values from specified test conditions	Maximum variation of individual readings from specified test conditions
Temperature of air entering: dry-bulb wet-bulb	 ±0,3 °C ± 0,2 °C	 ±0,5 °C ± 0,3 °C
Air volume flow rate	±5 %	±10 %
Air static pressure at zero pressure	±2,5 Pa	±5 Pa
Air static pressure ≤ 100 Pa	±5 Pa	±10 Pa
Air static pressure at > 100 Pa	±5 %	±10 %
Voltage	±1 %	±2 %

Annex G
(informative)

Construction of plenums for connection to inlets or outlets not designed for connection of ductwork

G.1 General

G.1.1 When one or more of the ventilator inlets or outlets are not intended for connection of ductwork, it may be necessary to construct a plenum to convey the air to be measured to or from the temperature-measuring instruments, static pressure controller, airflow measuring apparatus and the like.



Key

1	static pressure tappings
2	ventilator under test
a	to measurement and static pressure control apparatus
b	$J = 2De$ where $De = \sqrt{(4AB/\pi)}$

NOTE 1 $J = 2De$ where $De = \sqrt{(4AB/\pi)}$ and A and B are the dimensions of the equipment's air outlet.

NOTE 2 V_2 is the average air velocity at PL.2.

Figure G.1 — Basic measurement principle schematic for discharge chamber requirements when using the indoor air enthalpy test method

G.1.2 Plenums should be constructed to provide discharge or intake conditions similar to those that would occur in an actual installation of the ventilator.

G.1.3 Plenums should be insulated as required to allow for accurate measurement of the air conditions.

G.1.4 Plenums should be constructed and static pressure taps located in the plenums. Plenums should be constructed and static pressure taps located in the plenums as shown in Figure G.1.

Bibliography

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[5] ISO/TR 9464:2008, *Guidelines for the use of ISO 5167:2003*

[6] ISO/TR 12767:2007, *Measurement of fluid flow by means of pressure differential devices — Guidelines on the effect of departure from the specifications and operating conditions given in ISO 5167*

[7] ISO/TR 15377:2007, *Measurement of fluid flow by means of pressure-differential devices — Guidelines for the specification of orifice plates, nozzles and Venturi tubes beyond the scope of ISO 5167*

[8] ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*