BS EN 13141-7:2010

BSI Standards Publication

Ventilation for buildings — Performance testing of components/products for residential ventilation

Part 7: Performance testing of a mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for single family dwelling

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National foreword

This British Standard is the UK implementation of EN 13141-7:2010. It supersedes BS EN 13141-7:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/2, Ventilation for buildings, heating and hot water services.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

Ventilation for buildings - Performance testing of components/products for residential ventilation - Part 7: Performance testing of a mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for single family dwellings

Ventilation des bâtiments - Essais de performance des composants/produits pour la ventilation des logements - Partie 7: Essais de performance des centrales double flux (y compris la récupération de chaleur) pour les systèmes de ventilation mécaniques prévus pour des logements individuels

Lüftung von Gebäuden - Leistungsprüfungen von Bauteilen/Produkten für die Lüftung von Wohnungen - Teil 7: Leistungsprüfung von mechanischen Zuluft- und Ablufteinheiten (einschließlich Wärmerückgewinnung) für mechanische Lüftungsanlagen in Wohneinheiten (Wohnung oder Einfamilienhaus)

This European Standard was approved by CEN on 25 September 2010.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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

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Contents

Foreword

This document (EN 13141-7:2010) has been prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2011, and conflicting national standards shall be withdrawn at the latest by May 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13141-7:2004.

Compared to the 2004 version, changes have been made to the following (sub)clauses, tables and annexes:

— modification of the test temperatures to be similar to those of heat pump;

— possibility of measuring supply and exhaust ventilation and heat pump;

— suppression of reference to EN 308 for heat exchangers particular test conditions, this standard define its own conditions;

— introduction of tracer gas method for leakages;

— dependence of leakages under/over pressure configurations on fan position in airflow;

— obligation of reporting the two temperature ratios (on exhaust and supply air);

— possibility of doing an optional test by measuring on the outdoor side of the building while the measure is made on the inside side of the building in the mandatory test (exhaust and supply air flow rate);

— possibility of giving humidity ratios, like for PAC, this allowed to test enthalpy heat exchangers;

— review of value for balanced mass flows at 3 %, over 3% declaration of unbalanced unit and report of the disbalance value;

— setting of the declared maximum air volume flow at 50 Pa by default in lack of other declaration;

— addition of the declared minimum air volume flow at Ptud/2 and minimum setting;

— creation of a reference point at Ptud/2 and 70 % of declared maximum air volume flow;

— correction of the temperature ratios considering flow rate ratios.

This standard is a part of a series of standards on residential ventilation. It has a parallel standard referring to the performance characteristics of the components/products for residential ventilation.

The position of this standard in the field of standards for the mechanical building services is shown in Figure 1.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

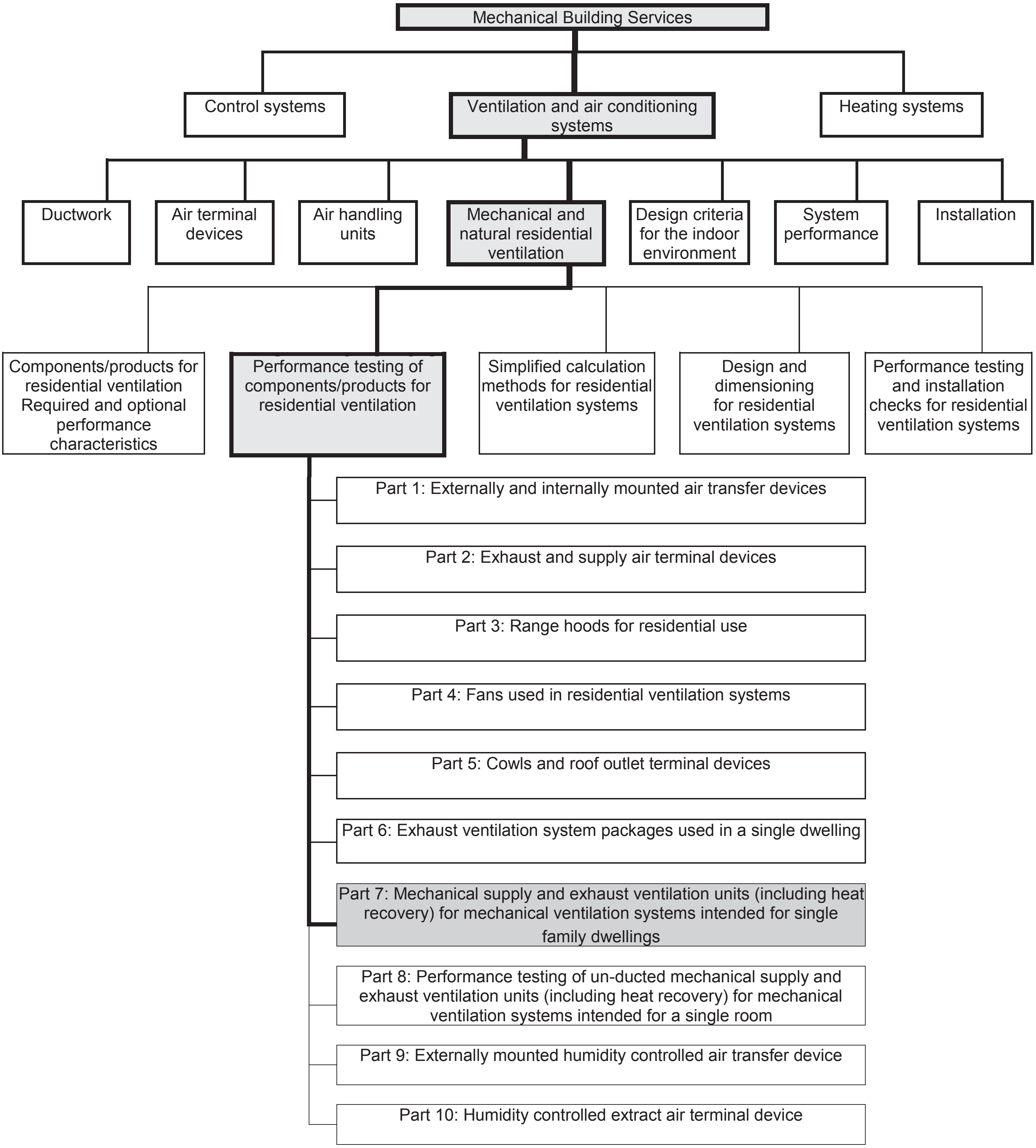


Figure 1 — Position of EN 13141-7 in the field of the mechanical building services

Introduction

This European Standard specifies methods for the performance testing of components used in residential ventilation systems to establish the performance characteristics as identified in EN 13142.

This European Standard does not contain any information on ductwork and fittings, which are covered by other European Standards.

The standard can be used for the following applications:

— laboratory testing;

— attestation purposes.

1 Scope

This part of EN 13141 specifies the laboratory test methods and test requirements for the testing of aerodynamic, thermal and acoustic performance, and the electrical performance characteristic of a mechanical supply and exhaust ventilation units used in a single dwelling.

It covers unit that contain at least, within one or more casing:

— supply and exhaust air fans;

— air filters;

— air-to-air heat exchanger and/or Extract Air-to-Outdoor Air heat pump for extract air heat recovery;

— control system.

Such unit can be provided in more than one assembly, the separate assemblies of which are designed to be used together.

The different possible arrangements of heat recovery heat exchangers and/or heat pumps are described in Annex A.

This standard does not deal with non-ducted units or reciprocating heat exchangers.

This standard does not deal with units that supply several dwellings.

This standard does not cover ventilation systems that may also provide water space heating and hot water.

This standard does not cover units including combustion engine driven compression heat pumps and absorption heat pumps.

Electrical safety requirements are given in EN 60335-2-40 and EN 60335-2-80.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 306, *Heat exchangers — Methods of measuring the parameters necessary for establishing the performance*

EN 12792:2003, *Ventilation for buildings — Symbols, terminology and graphical symbols*

EN 13141-4, *Ventilation for buildings — Performance testing of components/products for residential ventilation — Part 4: Fans used in residential ventilation systems*

EN 14511-2, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 2: Test conditions*

EN 14511-3, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 3: Test methods*

EN 14511-4, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 4: Requirements*

EN ISO 3741, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for reverberation rooms (ISO 3741:1999, including Cor 1:2001)*

EN ISO 3743-1, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for hard-walled test rooms (ISO 3743-1:1994)*

EN ISO 3743-2, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms (ISO 3743-2:1994)*

EN ISO 3744, *Acoustics — Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane (ISO 3744:1994)*

EN ISO 3745, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and semi-anechoic rooms (ISO 3745:2003)*

EN ISO 5135, *Acoustics — Determination of sound power levels of noise from air-terminal devices, air-terminal units, dampers and valves by measurement in a reverberation room (ISO 5135:1997)*

EN ISO 5136, *Acoustics — Determination of sound power radiated into a duct by fans and other air-moving devices — In-duct method (ISO 5136:2003)*

EN ISO 9614-1, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points (ISO 9614-1:1993)*

EN ISO 9614-2, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning (ISO 9614-2:1996)*

3 Terms, definitions and classification

For the purposes of this document, the terms and definitions given in EN 12792:2003 and the following apply.

3.1 Terms and definitions

3.1.1
external leakage
leakage to or from the air flowing inside the casing of the unit to or from the surrounding air

3.1.2
internal leakage
leakage inside the unit between the exhaust and the supply air flows

3.1.3
filter bypass leakage
air flow around filter cells

3.1.4
declared maximum air volume flow
air volume flow corresponding to the declared total pressure of the unit at the maximum setting for standard air conditions (20 °C, 101325 Pa)

3.1.5
declared minimum air volume flow
air volume flow corresponding to Ptud/2 Pa at the minimum setting for standard air conditions (20 °C, 101325 Pa)

3.1.6
Ptud/2
declared total pressure difference between the outlet and the inlet of the unit

3.1.7
temperature ratio
temperature difference between inlet and outlet of one of the air flows divided by the temperature difference between the inlets of both air flows

3.1.8
electric power input
average electrical power input to the equipment within a defined interval of time, in watts, obtained from:

- the power input of the fans;
- the power input for operation of any compressor(s) and any power input for defrosting, excluding additional electrical heating devices not used for defrosting;
- the power input of all control and safety devices of the equipment

3.1.9
test voltage
voltage to be used for supplying the components during the testing

3.1.10
humidity ratio
difference of water content between inlet and outlet of one of the air flows divided by the difference of water content between the inlets of both air flows

3.1.11
recirculation fraction (R)
mass fraction of the discharged air to a zone (see Figure 2: from key 4 (extract) to key 5 (supply)) that is actually recirculated air from the same zone, due to internal leakage, external casing leakage and local short-circuiting

3.2 Categories of heat exchangers

Category I: Recuperative heat exchangers (e.g. air-to-air plate or tube heat exchanger)

Recuperative heat exchangers are designed to transfer thermal energy (sensible or total) from one air stream to another without moving parts. Heat transfer surfaces are in form of plates or tubes. This heat exchanger may have parallel flow, cross flow or counterflow construction or a combination of these. Plate and tube heat exchangers with vapour diffusion (for instance cellulose) are also in this category.

Category II: Regenerative heat exchangers (e.g. rotary or reciprocating heat exchanger)

A rotary heat exchanger is a device incorporating a rotating “thermal wheel” for the purpose of transferring energy (sensible or total) from one air stream to the other. It incorporates material allowing latent heat transfer, a drive mechanism, a casing or frame, and includes any seals which are provided to retard bypassing and leakage or air from one air stream to the other. Regenerative heat exchangers have varying degrees of moisture recovery, depending on the material used (e.g. "condensation rotor/non hygroscopic rotor", "hygroscopic rotor" and 'sorption rotor" heat exchangers).

4 Symbols and abbreviations

For the purposes of this document, the symbols and abbreviations given in EN 12792:2003 and the following apply.

c	Concentration of tracer gas	ppm
D	Diameter of the measurement duct (see Figure 2)	in m
D_{h1}, D_{h2}	Hydraulic diameters of the connecting duct (see Figure 3)	in m
L_W	Sound power level	in dB
L_{WA}	A-weighted sound power level	in dB
p_s	Static pressure	In Pa
P_E	Effective power input	in W
p_{tU}	Total pressure difference between the outlet and the inlet of the unit	in Pa
p_{tUd}	Declared total pressure difference between the outlet and the inlet of the unit	in Pa
q_m	Mass air flow rate	in $kg.s^{-1}$ or $g.s^{-1}$
q_v	Volume flow rate	in $m^3.s^{-1}$ or $l.s^{-1}$
q_{vn}	Nominal air volume flow	in $m^3.s^{-1}$ or $l.s^{-1}$
q_{vd}	Declared maximum air volume flow rate	in $m^3.s^{-1}$ or $l.s^{-1}$
q_{ve}	External leakage air volume flow rate	in $m^3.s^{-1}$ or $l.s^{-1}$
q_{vi}	Internal leakage air volume flow rate	in $m^3.s^{-1}$ or $l.s^{-1}$
R	Recirculation fraction, measured with tracer gas test.	-
V	Air velocity in the measurement duct (see Figure 3)	in $m.s^{-1}$
θ	Air temperature	in °C
x	water content	in kg water / kg dry air
21	Outdoor air (see Figure 2)	
22	Supply air (see Figure 2)	
11	Extract air (see Figure 2)	
12	Exhaust air (see Figure 2)	
$\eta_{\theta, ex}$	Temperature ratio of the unit on exhaust air side	
$\eta_{\theta, su}$	Temperature ratio of the unit on supply air side	
$\eta_{x, ex}$	Humidity ratio of the unit on exhaust air side	
$\eta_{x, su}$	Humidity ratio of the unit on supply air side	

5 Requirements

To set the declared maximum air volume flow, the declared total pressure shall correspond to 100 Pa, or to a lower total pressure if the intended use declared by the manufacturer is less than 100 Pa.

The declared maximum air volume flow shall be equal to the smaller if the supply and extract air volume flows are different.

In addition, to assess correctly the thermal performance, aerodynamic characteristics, including all leakages, shall be tested before or together with any thermal characteristics testing (see 6.3).

Aerodynamic characteristics (see 6.2) shall include three characteristics listed below:

- external leakage or total recirculated fraction in supply air;
- internal leakage or recirculated fraction from extract to supply air or total recirculated fraction in supply air;
- air flow/pressure curve;

Other characteristics such as filter bypass leakage are optional.

The tests for air flow/pressure curve and thermal performances shall not be made because of measurement uncertainty when leakages according to 6.2.1 are too high. The unit shall have the leakage class specified in Table 1.

Table 1 — Classification requirements for thermal performance

	Supply fan upstream and exhaust fan downstream of the heat exchanger or Exhaust fan upstream and supply fan downstream of the heat exchanger[a]	Other fan positions
required class to allow measurements	Class A1, A2, B1, B2, C1, C2	All classified units

[a] This configuration is not recommended for good Indoor air quality.

The manufacturer shall declare:

- maximum air volume flow;
- maximum disbalance air flow;
- declared total pressure difference of the unit;
- minimum air volume flow;
- minimum outside operation temperature;
- filter classes supply and exhaust air;
- balancing of air volume flows;
- presence of by-pass and its control;
- frost protection function and control (for cold climate test).

6 Test methods

6.1 General

Tests shall be conducted with a unit containing all components as supplied for intended use, and installed according to the manufacturer's instructions.

For units which are intended to be used in dwellings of different sizes (e.g. 4, 5 or 6 rooms), the tests shall be made in the “maximum” configuration (i.e. 6 rooms).

Where a single value is assigned by the manufacturer as rated voltage, this shall be the test voltage. Where a voltage range is assigned to the product by the manufacturer that includes 230 V, the test shall be conducted at 230 V. This voltage shall be maintained throughout the testing to ± 1 %.

6.2 Performance testing of aerodynamic characteristics

6.2.1 Leakages

6.2.1.1 General

There are two methods for rating leakages, pressure testing and tracer gas testing (see Annexes B and C):

— The pressure method applies to classify leakages of category I heat exchanger unit;

— The tracer gas method applies to classify leakages of category II heat exchanger unit.

There are four classes of leakage depending on the ratios between both leakage air flows and maximum declared air volume.

6.2.1.2 Pressurisation test methods (internal and external leakage) and classification

Pressure method applies to classify leakages of category I heat exchanger unit by using Table 2.

Table 2 — Leakage classification – pressure method

Class	Pressurization test		
	Internal leakage (at 100 Pa)		**External leakage** (at 250 Pa)
A1	≤ 2 %	and	≤ 2 %
A2	≤ 5 %	and	≤ 5 %
A3	≤ 10 %	and	≤ 10 %
not classified	> 10 %	or	> 10 %

The external and internal leakage shall be measured according to Annex B.

The external leakage air volume flow q_{ve} at over and/or under pressure of 250 Pa, according to Table 3, shall be reported as such and also compared to the declared maximum air volume flow of the unit as a percentage.

At least three different measurement points evenly distributed shall be made between 100 Pa and 300 Pa, and reported by means of a curve.

Both over pressure and under pressure shall be reported. If one of these tests is not required (see Table 5), the report shall then mention “not required”.

Table 3 — Pressure conditions during external leakage test

Supply fan position	Upstream of the heat exchanger	upstream of the heat exchanger	downstream of the heat exchanger	downstream of the heat exchanger
Exhaust fan position	upstream of the heat exchanger	downstream of the heat exchanger	upstream of the heat exchanger	downstream of the heat exchanger
Tests conditions for external leakages	over-pressure	over and under-pressure	over and under-pressure	under-pressure

The internal leakage air volume flow q_{vi} at a pressure difference of 100 Pa shall be reported as such and also compared to the declared maximum air volume flow of the unit as a percentage.

Different measurement points shall be made between 50 Pa and 200 Pa, and reported by means of a curve.

During the pressurisation tests for external and internal leakages, the fans of the unit under test shall be switched off.

6.2.1.3 Tracer gas method

Tracer gas method applies to classify leakages of category II heat exchanger unit. There are two options for this (see Annex C), either a chamber method determining the total recirculated fraction (internal and external leakages) or an in-duct method determining by pressurisation the external leakage and by tracer gas the internal part only in the recirculation fraction. In case of chamber method, classes of Table 4 shall be used. In case of in-duct method, classes of Table 5 shall be used.

The chamber method can be used in all cases, whilst the in-duct method is only applicable if the unit is classified C1, C2 or C3 according to Table 5, which means that the casing leakage is negligible.

Table 4 — Leakage classification –chamber tracer gas method

Class	**Total Recirculated fraction in supply air ($R_{s,tot}$)**
B1	≤ 1 %
B2	≤ 2 %
B3	≤ 6 %
not classified	> 6 %

Table 5 — Leakage classification – in-duct tracer gas method

Class	**Tracer gas test**		**Pressurisation test**
	Internal Recirculated fraction from extract to supply air ($R_{s,int}$)		**External leakage** (at 250 Pa)
C1	≤ 0,5 %	and	≤ 2 %
C2	≤ 2 %	and	≤ 2 %
C3	≤ 4 %	and	≤ 2 %
not classified	> 4 %	or	> 2 %

Concerning internal recirculated fraction from extract to supply air, air flow shall be measured according to 6.2.2 at the declared maximum air volume flow.

Where a test on a single unit results in different classes the product shall receive the worst classification. According to this the unit has only one leakage class.

6.2.2 Air flow/pressure curve

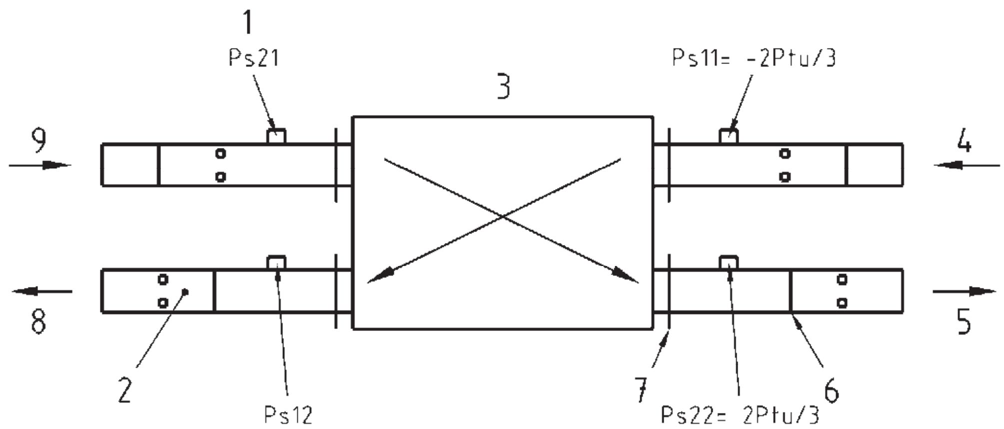
The air flow/pressure characteristic, for both supply and extract air flows, shall be determined according to EN 13141-4.

Tests shall be made in accordance with category D installation (ducted inlet and outlet) as defined in EN 13141-4. The fans shall be switched on. The measurement concerning both supply and extract air flows shall be performed simultaneously. The test installation and test conditions shall comply to Figure 2 for single inlet/outlet unit or Figure 3 for multiple inlet/outlet unit.

A minimum of 8 test points equally distributed shall be measured on each curve. A minimum of 3 curves per unit shall be measured on each fan for minimum setting, maximum setting and an intermediate setting that includes the reference point. When this is not achievable (e.g. 2 speed motor), only two curves are acceptable.

Total pressure (difference between the outlet and the inlet) of the unit p_{tu} at different air volume flows q_v and at different fan control adjustments shall be reported, at least at the maximum test voltage.

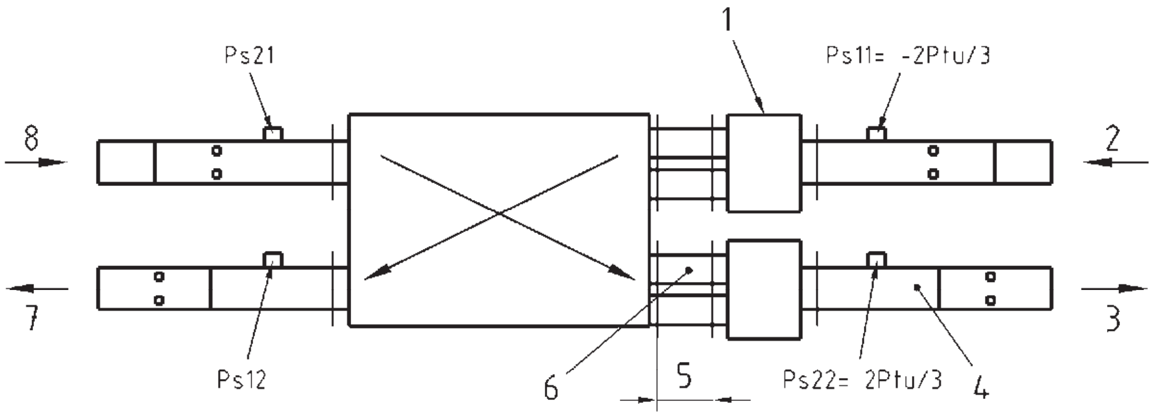
If a connection box is used, it shall be designed according to EN 13141-4 and described in the test report.



Key

1 pressure measurement
2 temperature and humidity measurement
3 unit under test
4 extract
5 supply
6 perforated plate
7 connection
8 exhaust
9 outdoor air

Figure 2 — Test installation and test conditions for single inlet/outlet unit



Key

1	connection box	5	1 to 2 DH2
2	extract	6	DH2
3	supply	7	exhaust
4	*D* so that $v \leq 2\ m.s^{-1}$	8	outdoor air

Figure 3 — Test installation and test conditions for multiple inlet/outlet unit

6.2.3 Filter bypass

The filter bypass leakage characteristic should be determined with a visual inspection including all the following details:

— Design and construction of the air filters and frames shall allow an easy assembly and ensure a tight fit.

— Tight fit shall not be affected under the impact of humidity (that means materials shall not be affected from humidity and water, for example a metal, plastic or impregnated cardboard frame).

6.3 Performance testing of thermal characteristics

6.3.1 General

The units with air-to-air heat exchanger shall be tested according to 6.3.2 and the units including heat pump exhaust air/outdoor air shall be tested according to 6.3.3. If the unit contains both, it shall be tested:

— with the air-to-air heat exchanger only according to 6.3.2 (heat pump switched off), and

— with the heat pump exhaust air/outdoor air according to 6.3.3, the air-to-air heat exchanger inside.

NOTE Typical arrangements of units are given in Annex A.

Temperature and humidity ratios shall be determined for the types of heat recovery heat exchangers as defined in 3.2, using the following formulas, corrected for mass flow balance.

6.3.2 Temperature and humidity ratios

6.3.2.1 Temperature and humidity ratios on supply air side (mandatory measurement)

Temperature ratio on supply air side $$\eta_{\theta,\ su} = \frac{\theta_{22} - \theta_{21}}{\theta_{11} - \theta_{21}} . \frac{q_{\mathrm{m22}}}{q_{\mathrm{m11}}} \quad (1)$$

Humidity ratio on supply air side $$\eta_{x,su} = \frac{x_{22} - x_{21}}{x_{11} - x_{21}} . \frac{q_{\mathrm{m22}}}{q_{\mathrm{m11}}} \quad (2)$$

For balanced units, the mass flows q_{m11} (extract air) and q_{m22} (supply air) shall be balanced to within 3 % regarding extract air flow (q_{m11}). Over 3%, the unit is declared unbalanced and the imbalance shall be reported.

6.3.2.2 Temperature and humidity ratios on exhaust air side (optional measurement)

Temperature ratio on exhaust air side $$\eta_{\theta,\ ex} = \frac{\theta_{11} - \theta_{12}}{\theta_{11} - \theta_{21}} . \frac{q_{\mathrm{m12}}}{q_{\mathrm{m21}}} \quad (3)$$

Humidity ratio on exhaust air side $$\eta_{x,ex} = \frac{x_{11} - x_{12}}{x_{11} - x_{21}} . \frac{q_{\mathrm{m12}}}{q_{\mathrm{m21}}} \quad (4)$$

For balanced units, the mass flows q_{m12} (exhaust air) and q_{m21} (outdoor air) shall be balanced to within 3 % regarding exhaust air flow (q_{m12}). Over 3 %, the unit is declared unbalanced and the imbalance shall be reported.

6.3.2.3 Test requirements

For category II of heat exchangers the nominal rotor speed specified by the manufacturer shall be used.

For rotary exchangers of category II, the purge sector shall be adjusted in accordance with the recommendations of the manufacturer.

With the exception of automated defrost heaters, heaters in the unit shall not operate during the tests.

6.3.2.4 Test operating conditions

For the thermal tests, adjusting the airflow is conducted only once, at the mandatory heating point (7 °C/20 °C, see Table 6) for all heating tests and tests in cold climate. When applicable, balancing is conducted for mandatory cooling point for all cooling tests. Any balancing dampers are locked firmly to prevent creep during the duration of the remaining thermal tests. At other simulated outdoor temperatures, the balancing can be expected to deteriorate very slightly due only to changes in the density of air in the supply and exhaust streams but no additional adjustment is needed.

In case of optional test on exhaust side the procedure shall be repeated from the beginning.

The ambient temperature of the unit shall be maintained at the same dry bulb temperature than the extract air (11) ± 1 K.

The pressure conditions during measurements shall be according to Figures 2 and 3.

Temperature ratios for supply and extract air shall be measured at reference point and optional at minimum or maximum airflow and shall be reported

Humidity ratios for supply and extract air shall be measured at reference point and optionally at minimum or maximum airflow and shall be reported for any exchanger of category II.

NOTE If ratios for supply and exhaust are much different, several causes are possible: thermal bridges, leakage, fan absorbed power. To investigate this, it is sometimes possible to compare test results with and without over insulation of the casing or to use tracer gas measurements.

The reference point shall be defined at $P_{tUd}/2$ and 70 % of declared maximum air volume flow. If this point cannot be set, pressure shall remain at $P_{tUd}/2$ and airflow shall be adjusted just over.

Maximum air flow point shall be adjusted at P_{tUd} and declared maximum air volume flow. If this point cannot be set, pressure shall be adjusted just over P_{tUd}.

Minimum air flow point shall be adjusted at $P_{tUd}/2$ and declared minimum air volume flow.

No correction to the temperature ratio shall be made for the power input of the fans or other components.

6.3.2.5 Temperature conditions

Thermal tests shall be performed at the temperature conditions for standard test, accordingly to the type and use of the heat recovery device (see Table 6):

- Point 1 is a dry air test, mandatory for all units;
- Point 2 is an intermediate point, mandatory for units category II and optional for category I for condensation;
- Point 3 is an optional point intended to show extreme condensation conditions;
- Point 4 is an optional point for cold climate. The test shall run for a minimum of 6 h up to maximum of 24 h to a point where the airflow is stabilised.

If condensation occurs, then the condensation test shall also be performed.

If the unit is designed to operate at outdoor temperature below -15 °C, then the cold climate test shall be performed.

Table 6 — Temperature conditions

Application mode	**Standard test**			**Cold climate test**[a]
Point Number	1	2	3	4
Heat exchanger category	I and II (mandatory point)	I (optional) and II (mandatory)	I and II(optional)	I and II (optional)
Extract air				
Temperature θ_{11}	20 °C	20 °C	20 °C	20 °C
Wet bulb temperature θ_{w11}	12 °C	15 °C	12 °C	10 °C
Outdoor air				
Temperature θ_{21}	7 °C	2 °C	-7 °C	-15 °C
Wet bulb temperature θ_{w21}	-	1 °C	-8 °C	-

[a] additional test for cold climates.

Following a test for cold climates, the unit shall be visually inspected. This inspection shall be carried out immediately after defrosting or other similar action. Observations shall be noted in the test report as to the influence of freezing and condensation on the operation of the heat recovery device, and the condensation water outlet.

6.3.2.6 Test procedure

The temperature and humidity ratios shall be established by measuring the mean values of dry and wet bulb temperatures in sections 11, 22, 21 and optional 12 in case of measuring for an exhaust temperature ratio.

In each of the ducts connected to the unit, a temperature measuring plane shall be arranged to determine air temperature:

— For diameter ≤ 125 mm, at 3 points evenly distributed over the cross-section;

— For diameter > 125 mm, at 5 points evenly distributed over the cross-section.

The distance between the unit to the measuring plane shall be such that the change in mean air temperature in the ducts is not greater than 0,1K.

Uncertainties of each measurements shall comply with the values of the following Table 7.

Table 7 — Uncertainties of measurement

Measured quantity	Uncertainty of measurement
Dry bulb temperature	± 0,2 K
Wet bulb temperature	± 0,3 K
Air flow rate	± 3 %

Steady state conditions are considered obtained and maintained when all the measured quantities remain constant without having to alter the set values, for a minimum duration of 1 h, with respect to the tolerances given in Table 8. Periodic fluctuations of measured quantities caused by the operation of regulation and control devices are permissible, on condition the mean value of such fluctuations does not exceed the permissible deviations listed in Table 8.

For the output measurement, it is necessary to record all the meaningful data continuously. In the case of recording instruments which operate on a cyclic basis, the sequence shall be adjusted such that a complete recording is effected at least once every 30 s.

The duration of measurement shall not be less than 30 min.

Table 8 — Permissible deviations from set values

Measured quantity	Permissible deviation of the arithmetic mean values from set values	Permissible deviation of individual measured values from set values
Air (supply and extract)		
- inlet temperature (dry bulb)	± 0,3 K	± 1 K
- inlet temperature (wet bulb)	± 0,3 K	± 1 K
- volume flow rate	± 5 K	± 10 %
- pressure	-	± 10 %
Voltage	± 1 %	± 1 %

6.3.3 Heat pump performance

When the system includes an exhaust air / outdoor air heat pump, the performance test consists of the determination of the heating capacity and the coefficient of performance (COP) of the heat pump as defined in EN 14511.

The tests shall be performed in accordance with the temperature conditions defined in EN 14511-2 and specified in Table 9.

Table 9 — Temperature conditions for the heating performance test

Extract air inlet dry bulb (wet bulb) temperature	Outdoor air inlet dry bulb (wet bulb) temperature
20 (12) °C	7(6) °C
20 (12) °C	2(1) °C
20 (12) °C	-7(-8) °C

In the case of reverse cycle heat pump, the performance in cooling mode, i.e. cooling capacity and energy efficiency ratio (EER) shall also be measured in the temperature conditions given in Table 10.

Table 10 — Temperature conditions for the cooling performance test

Point for cooling performance	Extract air inlet dry bulb (wet bulb) temperature	Outdoor air inlet dry bulb (wet bulb) temperature
1 (mandatory)	27 (19) °C	35 (24) °C
2 (optional)	27 (19) °C	27 (19) °C

For operating conditions, the tests shall be performed as described in 6.3.2.4 for reference point and optional at minimum or maximum airflow and shall be reported.

The heating and/or cooling performance shall be determined in accordance with the test methods and procedures as described in EN 14511-3.

6.3.4 Combined heat pump and air-to-air heat exchanger performance

When the system includes both an air-to-air heat recovery heat exchanger and an exhaust air / outdoor air heat pump, the performance tests are conducted in accordance with 6.3.3, the temperature conditions being defined at the inlets of the combined system, in heating and cooling mode where applicable.

In case the system is designed to operate with a mixed combination of extract air and additional outdoor air at the evaporator with a ratio specified by the manufacturer, additional tests shall be performed to determine the performance of the system in such a configuration of operation. These performance tests shall be conducted in accordance with 6.3.3, and with the additional outdoor airflow rate specified by the manufacturer, the temperature conditions given in Table 9 and Table 10, being defined at the inlets of the combined system.

6.4 Performance testing of acoustic characteristics

6.4.1 Noise radiated through the casing of the unit

Acoustic measurement shall be carried out according to engineering methods described in EN ISO 3743-1 or EN ISO 3743-2 (reverberation room), EN ISO 3744 (free field) or EN ISO 9614-1 or EN ISO 9614-2 (sound intensity) or according respectively to the following precision methods described in EN ISO 3741, EN ISO 3745 or EN ISO 9614-1.

The unit shall be installed according to the manufacturer's instructions.

To reduce the sound power radiated from the ducts, only rigid ducts shall be used.

Laboratory shall ensure that the radiated noise from ducts shall not influence the measurement of noise radiated from the unit. If the duct radiation is too high, insulated ducts shall be used (double skin).

Airflow control devices used by laboratories shall not interfere with acoustic measurements.

Sound power levels shall be determined at the declared maximum air volume flow. The following data shall be included in the report:

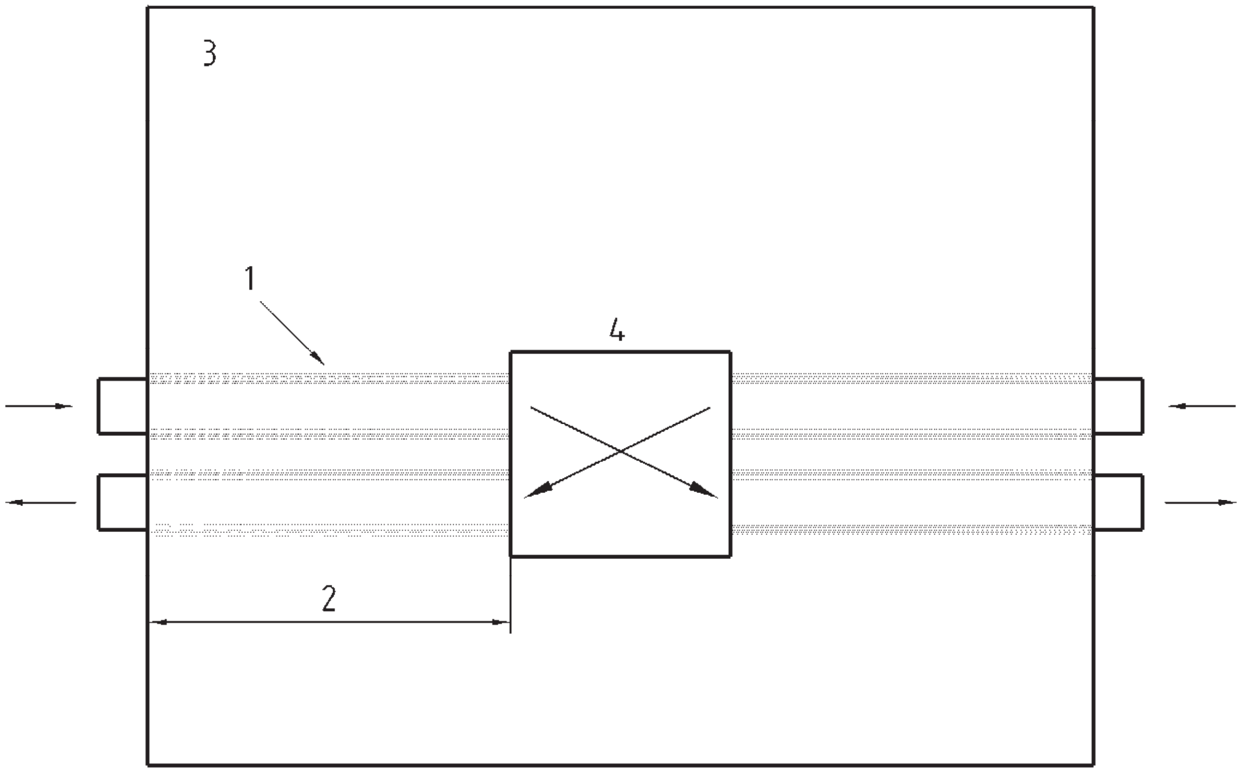
— sound power level L_{W};

— A-weighted sound power level L_{WA};

— sound power levels in octave bands between 125 Hz and 8000 Hz;

— declared maximum air volume flow q_{vd};

An example of a test installation is given in Figure 4.



Key

1 rigid duct
2 minimum length as possible
3 test room
4 unit under test

Figure 4 — Example of test installation for measuring the noise production through the casing of the unit

6.4.2 Sound power level in duct connections of the unit

The acoustic measurements shall be carried out according to EN ISO 5135 by identifying the inlets/outlets unit as a terminal unit or in duct according to EN ISO 5136.

The duct end correction, according to EN ISO 5135, shall be applied to the sound power levels measured at the duct discharge (in the reverberation room), to determine the sound power levels at each duct connection of the unit.

Airflow control devices used by laboratories shall not interfere with acoustic measurements.

In any case, sound absorptive material shall not be present into the duct under measurement.

The unit shall be installed according to the manufacturer's instructions.

Sound power levels at each duct connection of the unit shall be determined at the declared maximum air volume flow. The connecting ducts shall be rigid and insulated to limit losses by transmission ". The following data should be included in the report:

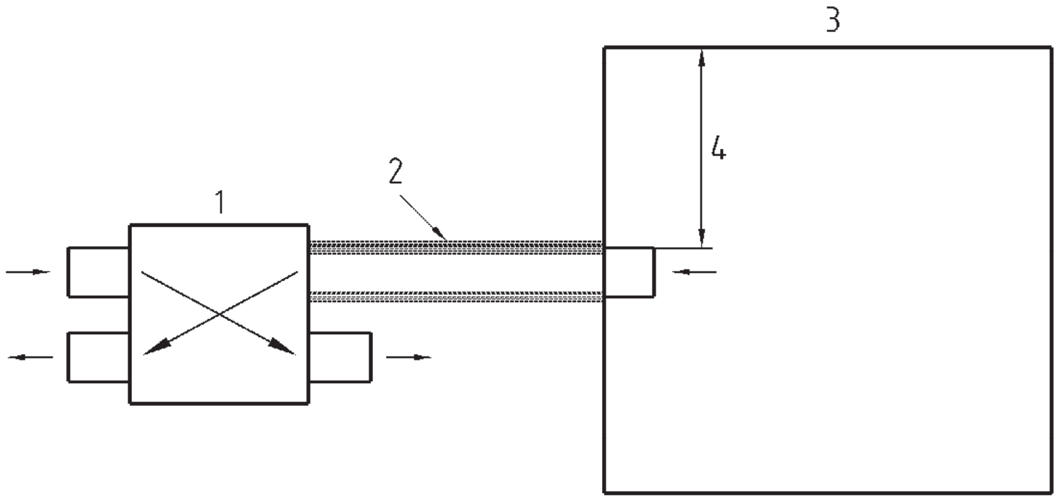
— sound power level L_W ;

— A-weighted sound power level L_{WA};

— sound power levels in octave bands between 125 Hz and 8000 Hz;

— declared maximum air volume flow q_{vd}.

Figure 5 gives an example of test installation using reverberation chamber.



Key

1 unit

2 rigid duct, length = 1,5 m

3 reverberation room

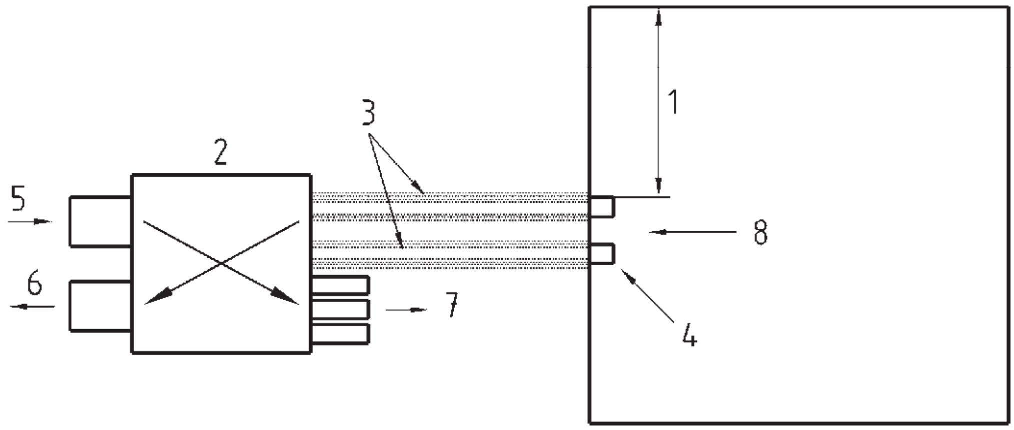
4 min. 1 m (from all surfaces)

Figure 5 — Example of test installation for measuring the sound power level at the connections of the unit

For units with two inlets/outlets, only one measurement for the inlets and one measurement for the outlets should be done with all the duct connections connected to the room. Then the sound power level at each duct connection shall be calculated using the global result and assuming that the connections are equivalent.

For multiple inlets/outlets units (more than two), one test shall be made for each type of inlet/outlet.

An example of a test installation for a unit with multiple inlets/outlets is given in Figure 6.



Key

1 min. 1m (from all surfaces)
2 unit
3 insulated rigid duct (to reduce noise emission) length = 1,5 m
4 duct connections under test
5 supply
6 exhaust
7 supply. three inlets
8 extract. two outlets with same diameters

Figure 6 — Example of a test installation for a unit with multiple inlets/outlets

Whatever the number of outlets (inlets), if their diameter is identical, the sound power level of a single duct connection shall be calculated from the global sound power level of the N identical duct connections using:

Lw single = Lw global N + 10 lg (1/N)

The duct end correction shall be applied using the single connection section and not the sum of sections discharging in the reverberation room.

6.5 Electric power input

The electric power input P_E of a unit shall be measured in several modes when possible.

In active mode, the unit is connected to the mains power source and is providing the intended service. This means the controls system is operating and the unit provides suitable ventilation rates according to the control strategy.

The electric power input P_E shall be measured according to 6.2.3 or 6.3.3. In this case the electric power input is generally due to the electrical power of fans, compressors (heating and/or cooling), control, reheater (if present), etc.

The electric power input P_E shall be measured according to EN 13141-4 during the test specified in 6.3.2 and shall be reported.

If the test in 6.3.3 is performed, the electric power input P_E shall be measured according to EN 14511-3. The value shall be reported.

If the system includes a mode in which the fans are not operating and control components are still active (necessary for function of the unit internal or external), then the electric power input shall also be measured in this mode.

If the system can be switched off manually or with any remote control system and if the end of this mode is also given by a manual action, the electric power input has to be measured with the high voltage in operation.

7 Test results

7.1 Test report

The test report shall include at least the following information:

a) name and address of testing laboratory and location where the test was carried out when different from the address of the testing laboratory;

b) unique identification of report (such as serial number) and of each page, and total number of pages of the report;

c) name and address of the client;

d) description and identification of the test item (including the position of the fan);

e) date of receipt of test item and date(s) of performance of test;

f) identification of the test specification or description of the procedure;

g) description of the sampling procedure, where relevant;

h) any deviations, additions to or exclusions from the test specification, and any other information relevant to a specific test;

i) identification of any non-standard test method or procedure utilised;

j) measurements, examinations and derived results, supported by tables, graphs, sketches and photographs as appropriate, and any failures identified; (see 7.2 to 7.9);

k) a statement on measurement uncertainty;

l) a signature and title or an equivalent marking of person(s) accepting technical responsibility for the test report and date of issue;

m) a statement to the effect that the results are only for the items tested;

n) qualitative specification of visual inspection of the filter, if appropriate.

7.2 Product specifications

The equipment specification shall be given as follows:

— declared maximum air volume flow: q_{vd} in $l.s^{-1}$;

— nominal air volume flow: q_{vn} in $l.s^{-1}$;

— declared total pressure: p_{tUd} in Pa;

— filter class.

7.3 Leakages

The equipment leakages established in accordance with 6.2.1 shall be given as follows:

For category I heat exchanger unit:

— external leakage: q_{ve} in $l.s^{-1}$;

- external leakage/declared maximum flow rate: q_{ve} / q_{vd} in %;
- internal leakage: q_{vi} in $l.s^{-1}$;
- internal leakage/declared maximum flow rate: q_{vi} / q_{vd} in %;
- external leakage/pressure curve;
- internal leakage/pressure curve;
- leakage class.

For category II heat exchanger unit tested with the in-duct tracer gas method:

- external leakage: q_{ve} in $l.s^{-1}$;
- external leakage/declared maximum flow rate: q_{ve} / q_{vd} in %;
- external leakage/pressure curve;
- internal recirculated fraction from extract to supply air $R_{s,int}$ in %;
- leakage class.

For category II heat exchanger unit tested with the chamber tracer gas method:

- total recirculated fraction in supply air $R_{s,tot}$ in %;
- leakage class.

7.4 Air flow/pressure curve

The air flow/pressure characteristic established in accordance with 6.2.2 for supply and extract air flows, for each voltage and for each setting shall be recorded as follows:

- total pressure difference between the outlet and the inlet of the unit: p_{tU} in Pa;
- air volume flow: q_v in $l.s^{-1}$.

For the same voltage, the results obtained for the different settings are drawn as curves, on the same figure.

A description of the connection box, if used, shall also be given.

7.5 Heat pump exhaust air/outdoor air performances

The thermal performances shall be reported according to EN 14511-4.

If one heat recovery was also present in the unit during the test, specify it in the report.

7.6 Temperature ratios

The temperature ratios shall be reported at every operating point in accordance with 6.3.2 and 6.3.3:

- temperature ratio for supply air without condensation;
- temperature ratio for exhaust air without condensation;
- temperature ratio for supply air with condensation;

- temperature ratio for exhaust air with condensation.

The following additional information may be provided for cold climates:

- temperature ratio for supply air;
- temperature ratio for exhaust air.

For cold climate test, observations shall be noted in the test report as to the influence of freezing and condensation on the operation of the heat recovery device, and the condensation water outlet.

Temperature ratios shall always be stated together with the leakage class of the unit (see 3.2).

Every operating point shall be recorded with all relevant information (air flows, pressure conditions, humidity values, temperature…).

7.7 Acoustic characteristics

For the assessment of noise radiated through the casing of the unit in accordance with 6.4.1, the presentation of the results shall include:

- test method;
- declared maximum air volume flow: q_{vd} in $l.s^{-1}$;
- declared total pressure: p_{tUd} in Pa;
- sound power levels in octave band: L_W in dB between 125 Hz and 8000 Hz;
- A-weighted sound power level: L_{WA} in dB(A).

For the sound power level at the duct connections of the unit in accordance with 6.4.2, the presentation of the results shall include:

- test method;
- declared maximum air volume flow: q_{vd} in $l.s^{-1}$;
- declared total pressure: p_{tUd} in Pa;

and for each type of duct connection:

- sound power levels in octave band: L_W in dB between 125 Hz and 8000 Hz;
- A-weighted sound power level: L_{WA} in dB(A).

7.8 Electric power input

For the electric power input the following results shall be reported.

- list of the major electrical components of the unit;
- total electric power input P_E at each point according to 6.5 in W;
- specific electric power input at reference point according to 6.3: P_E / q_v in $W/(l.s^{-1})$.

Annex A
(informative)

Example of some possible arrangements of heat recovery heat exchanger and/or heat pumps for category I

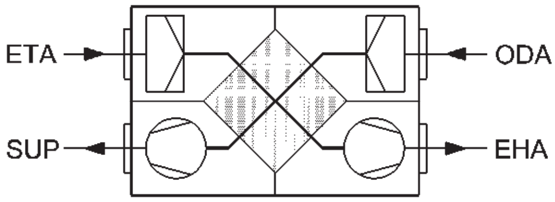


Figure A.1 — Example of Air handling unit with exhaust / Supply air heat exchanger

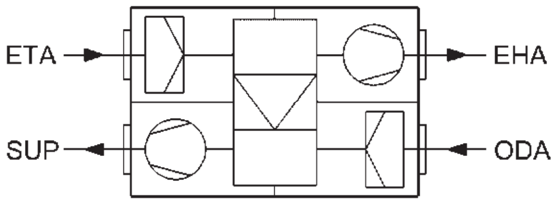


Figure A.2 — Example of Air handling unit with exhaust air/ supply air heat pump

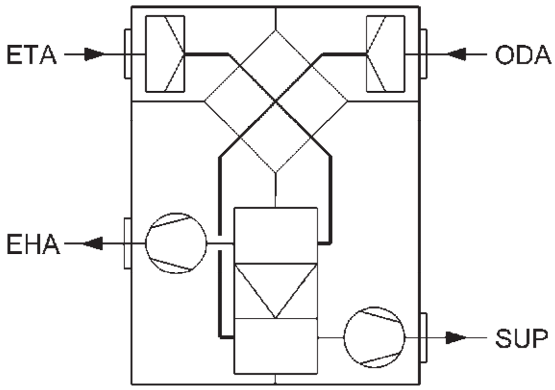


Figure A.3 — Example of Air handling unit with exhaust air/supply air heat exchanger and exhaust air-to-supply air heat pump

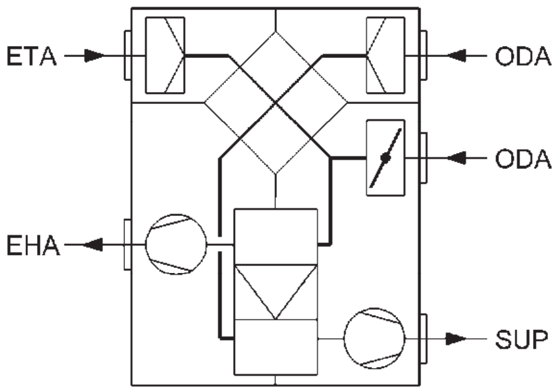


Figure A.4 — Example of Air handling unit with exhaust air/supply air heat exchanger and mixed exhaust air/outdoor air-to-supply air heat pump

Annex B
(normative)

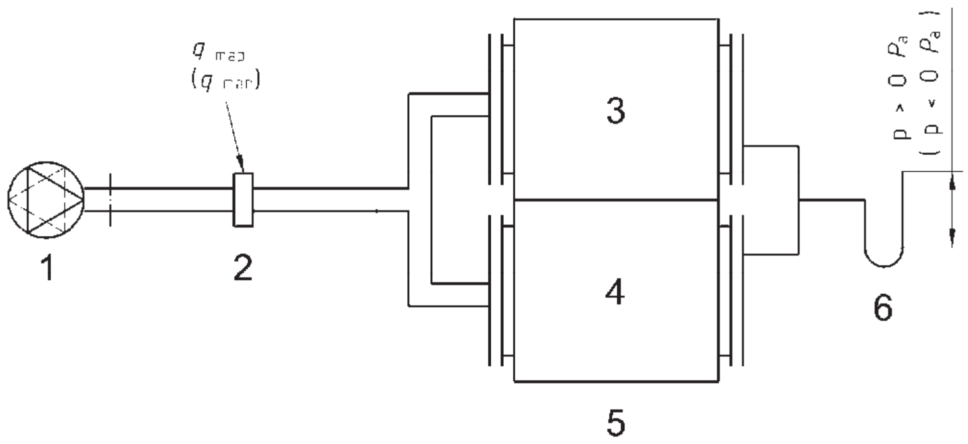
Pressure leakage test method

B.1 External leakage

The external leakage test shall be carried out by blanking off and sealing all ducts and connecting a fan to both the supply and the exhaust air sides of the recovery devices as shown in Figure B.1.

The static pressure of the casing shall be taken as the mean value at the two sides. Thus, static pressure tappings are located on a blanking off plate each side and both taps are connected to the same pressure measuring instrument. The external leakage flow rates at overpressure in the casing and at under pressure are established with suitable air flow measuring equipment.

The accuracy of the measured values shall be kept within ± 5 % for the flow rates and ± 3 % for the static pressures of the casing.



Key

1 adjustable fan
2 air flow measuring equipment
3 exhaust air side
4 supply air side
5 heat recovery device
6 static pressure measuring equipment

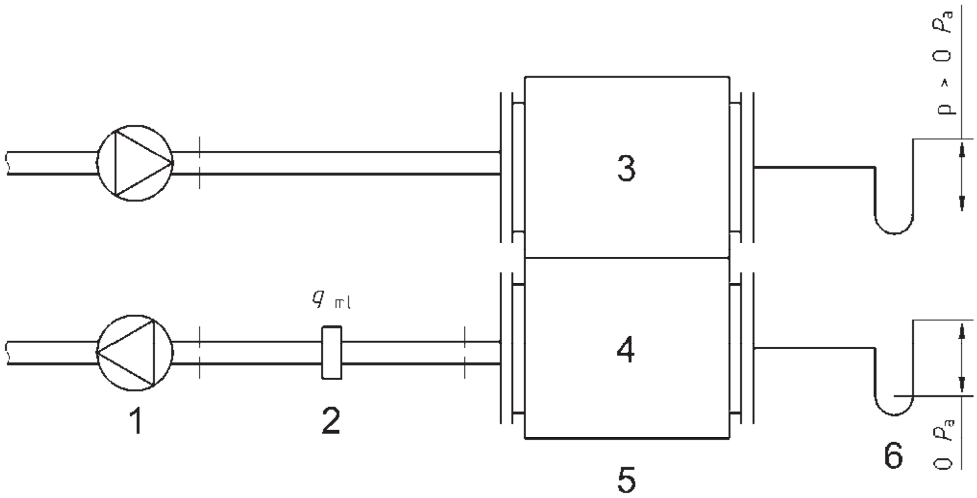
Figure B.1 — Test setup for leakage

Measurement devices shall comply with EN 306.

B.2 Internal leakage test

The internal leakage test shall be carried out by blanking off and sealing all ducts and connecting one supply fan to the exhaust air side and one exhaust fan to the supply air side of the recovery device as shown in Figure B.2. The overpressure on the exhaust air side is ascertained with the aid of a static pressure tapping in the blanking off plate and the pressure 0 Pa at a corresponding tapping on the supply side. The internal leakage flow rate is established with air flow measuring equipment connected to the supply air side.

The uncertainty of the measured values shall not exceed ± 5 % for the flow rate and ± 3 % for the static pressure difference between the two sides of the recovery device.



Key

1	adjustable fan	**4**	supply air side
2	air flow measuring equipment	**5**	heat recovery device
3	exhaust air side	**6**	static pressure measuring equipment

Figure B.2 — Test setup for internal leakage

Measurement devices shall comply with EN 306.

Annex C
(normative)

Tracer gas test method

C.1 General method for rating purposes

Figure C.4 illustrates the concurrent recirculation paths (external leakage and internal leakage/carry-over).There are two possible installation methods to measure:

— Chamber method (see Figures C.1 and C.2): test is performed in a chamber whereby the ventilation unit is surrounded by the “indoor air” from which the return air duct receives its air.

— In-duct method (see Figure C.4): If the casing leakage is negligible (ie ≤ 2% , confirmed by an external pressurization leakage test) then it is acceptable to perform an “in-duct” dosing instead of using a chamber.

The equations below are applicable irrespective of using the “in-duct” or chamber approach. Two tracer tests can be performed, which determine the fraction of recirculated air in each of the two outlets (supply for test 1 and exhaust for test 2) respectively. Test 1 on supply is mandatory to measure contaminant pollution of the supply air and test number 2 is optional and relevant only for leakage (purge sector…).

- Tracer gas test 1 on supply side (*mandatory*). A continuous stream of inert tracer gas is injected in a turbulent region before the return air inlet. The fresh air shall be almost free of tracer gas (Figure C.1 or C.4). The fraction of recirculated air in the supply air stream shall be calculated as follows:

$$R_s = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{c_{22,i} - c_{21,i}}{c_{11,i} - c_{21,i}}\right] \tag{C.1}$$

- Tracer gas test 2 on exhaust side (*optional*). A continuous stream of inert tracer gas is injected in a turbulent region before the fresh air inlet. The return air shall be almost free of tracer gas (Figure C.2).The fraction of recirculated air in the exhaust air stream shall be calculated as follows:

$$R_e = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{c_{12,i} - c_{11,i}}{c_{21,i} - c_{11,i}}\right] \tag{C.2}$$

In both tracer gas tests, the ventilation unit will be surrounded by air with the same concentration of tracer as the return air (c_{11}).

Tracer gas tests shall be performed at the declared maximum flow rate after the supply/extract flow rates have been balanced (and nominal pressure drops). The tests shall be conducted at flow air density in the range 1.16~1.24 kg/m³ during the duration of the tests, with no psychrometric changes other than the fans in the unit being tested.

Sufficient time shall be given for steady-state conditions to be achieved.

The air flow, pressure differential, power consumption, supply voltage, and tracer gas concentrations shall be measured.

A continuous air sample shall be drawn from each sampling point. Samples shall be drawn by a laboratory-approved procedure. Take care to avoid dilution in the sampling system.

C.2 Augmented method for measuring instantaneous recirculation of ducted units under different operating conditions (optional)

This section describes optional tests to determine recirculation during some specific cycles like frosting…

During the thermal tests (depending on the type of defrost system), or tests at lower flow rates, the instantaneous recirculation fraction can deviate from that measured during the tracer gas test. On the condition that the mass flow rate is measured in all four ducts, this instantaneous recirculation fraction can be estimated as follows:

Instantaneous apparent net recirculation fraction (measured for ducted units only) [1]

$$L_{\mathrm{i}} = \frac{q_{\mathrm{m_{dry}},21,\mathrm{i}} + q_{\mathrm{m_{dry}},12,\mathrm{i}}}{q_{\mathrm{m_{dry}},22,\mathrm{i}} + q_{\mathrm{m_{dry}},11,\mathrm{i}}} - 1 \quad \text{(C.3)}$$

Where the dry mass flow rates are calculated from the vapour mixing ratio (*w*) using

$$q_{\mathrm{m_{dry}}} = \frac{q_{\mathrm{m_{moist}}}}{1+w} \quad \text{(C.4)}$$

Instantaneous deviation from net recirculation fraction measured in tracer gas test

$$D_{\mathrm{i}} = \left| L_{\mathrm{i}} - \frac{R_{\mathrm{e}} - R_{\mathrm{s}}}{1 - R_{\mathrm{e}}} \right| \times 100\% \quad \text{(C.5)}$$

Instantaneous estimated true recirculation fractions, $R_{\mathrm{e,i}}$ and $R_{\mathrm{s,i}}$ (ducted units) [1]

(C.6)

If $\lvert D_{\mathrm{i}} \rvert \le 5\%$	$R_{\mathrm{s,i}} = R_{\mathrm{s}}$, $R_{\mathrm{e,i}} = R_{\mathrm{e}}$ i.e. use tracer gas test results
If $\lvert D_{\mathrm{i}} \rvert > 5\%$ and $\dot{m}_2 \le 0$ or $\dot{m}_4 \le 0$	$R_{\mathrm{s,i}} = 0$, $R_{\mathrm{e,i}} = 0$
If $\lvert D_{\mathrm{i}} \rvert > 5\%$ and $L_i > 0$	$R_{\mathrm{s,i}} = 0$, $R_{\mathrm{e,i}} = \min\left\{ R_{\mathrm{e,max}} , \max\left\{ 0 , 1 - \frac{\dot{m}_3}{\dot{m}_4} \right\} \right\}$
If $\lvert D_{\mathrm{i}} \rvert > 5\%$ and $L_{\mathrm{i}} \le 0$	$R_{\mathrm{e,i}} = 0$, $R_{\mathrm{s,i}} = \min\left\{ R_{\mathrm{s,max}} , \max\left\{ 0 , 1 - \frac{\dot{m}_1}{\dot{m}_2} \right\} \right\}$

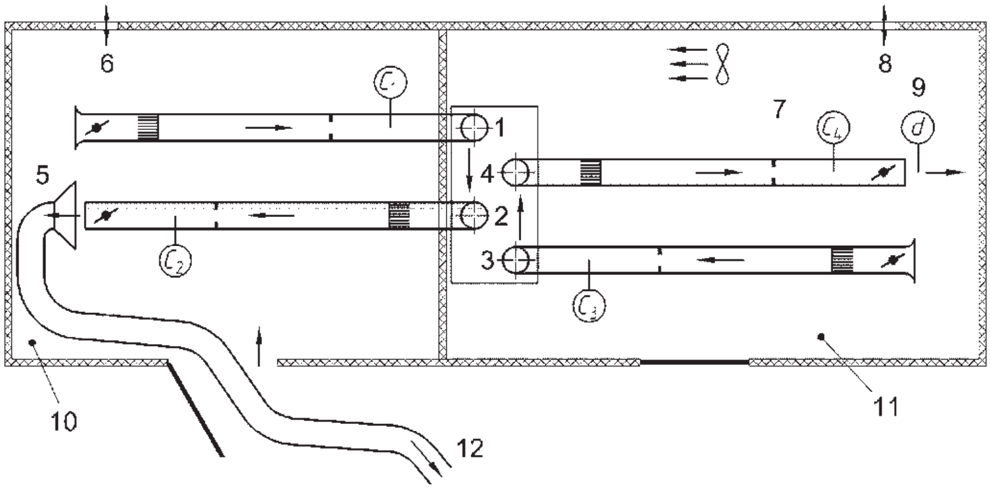
Instantaneous net fresh air volume flow rate

$$q_{\mathrm{v},22,\mathrm{i}} = \frac{q_{\mathrm{m_{dry}},22,\mathrm{i}} \left(1 - R_{\mathrm{s,i}}\right)\left(1 + w_{21,\mathrm{i}}\right)}{1{,}2} \quad \text{(C.7)}$$

---

[1] For non-ducted and half-ducted (reciprocating regenerative) units, L_i cannot be measured, so D_i is assumed to be equal to zero. However during the low-temperature thermal performance tests (Step 3) of non-ducted units that periodically recirculate air or stop the supply fan, the modified values of R_s and R_e during these periods can be estimated from measured velocity and using limit values of 0 or 1.

C.3 Testing orders for tracer gas tests

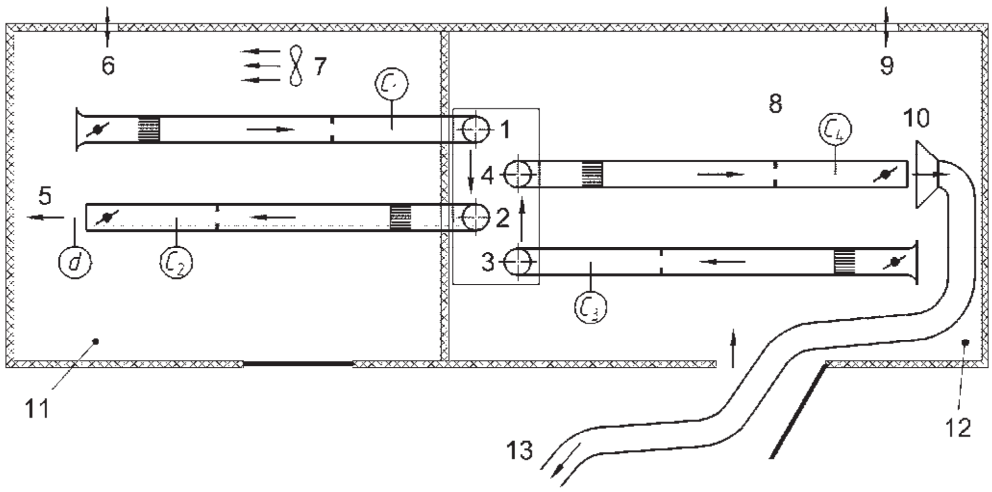


Key

1 fresh air inlet (21)
2 supply air outlet (22)
3 return air inlet (11)
4 exhaust air outlet (12)
5 local extract cone
6 hole to equalize pressure
7 sampling point for tracer gas
8 hole to equalize pressure
9 inert tracer gas dosed here in air jet
10 room with open door, infinitesimal concentration of tracer gas
11 room with closed door, high concentration of inert tracer gas, well mixed
12 to outside building via extract fan with variable speed control

Figure C.1 — Set-up for mandatory tracer gas test no.1 for ducted AHUs

The door to the 'outdoors' test room is left open. A duct with a sufficiently large opening diameter (or a formed cone) catches the supply jet discharged from the end of the supply duct. The cone is not directly connected to the end of the supply duct, and the extract flow rate is adjusted with an adjustable fan so that it is just a bit larger than the flow rate in the supply jet, thus minimising the dispersion of supply air in the test room, without affecting the pressure conditions in the supply duct. This is a "2 separate flow loops" configuration.



Key

1 fresh air inlet (21)

2 supply air outlet (22)

3 return air inlet (11)

4 exhaust air outlet (12)

5 inert tracer gas dosed here in air jet

6 hole to equalize pressure

7 circulation fan

8 sampling point for tracer gas

9 hole to equalize pressure

10 local extract cone

11 room with closed door, high concentration of inert tracer gas, well mixed

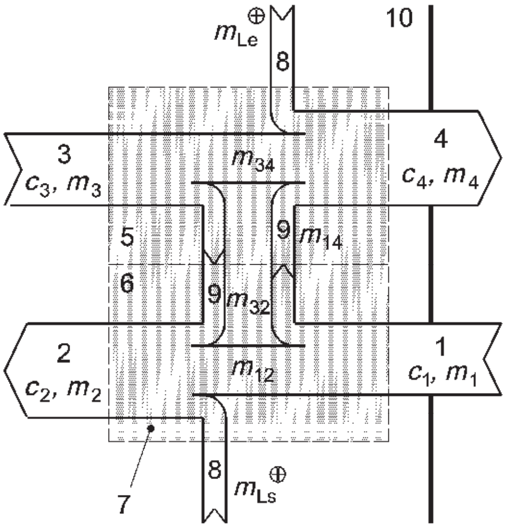
12 room with open door, infinitesimal concentration of tracer gas

13 to outside building via extract fan with variable speed control

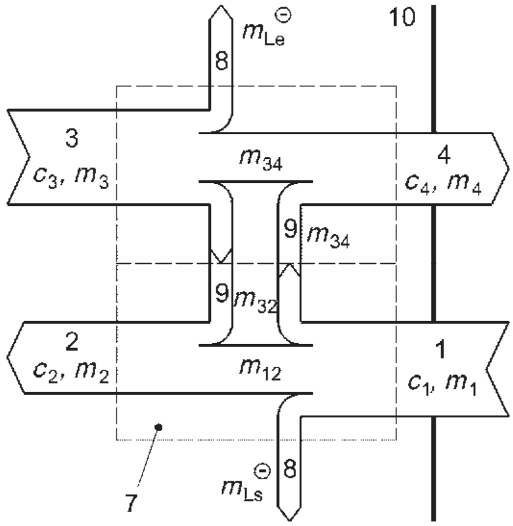
Figure C.2 — Set-up for optional tracer gas test no.2 for ducted AHUs

The door to the 'indoors' test room is left open. The extract cone is moved to catch the jet discharged from the exhaust air duct.

This is a "figure-of-8" flow configuration, which uses more tracer gas than that illustrated above in Figures C.1 and C.2.



C.3.a — with incoming net external leakage



C.3.b — with outgoing net external leakage

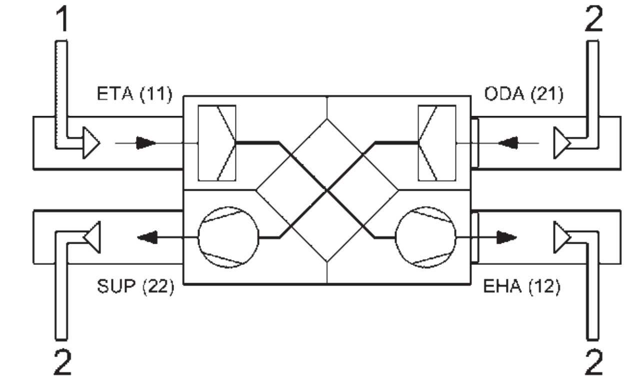
Key

1 fresh air inlet
2 supply air outlet
3 return air inlet
4 exhaust air outlet
5 extract side
6 supply side
7 ventilation unit
8 external leakage
9 internal leakage

Figure C.3 — Illustration of the ventilation unit's mass flow balance including the leakage paths that are analysed by tracer gas method, with either incoming or outgoing net external leakage

The tracer gas test can also measure any combination of (the two figures above) with incoming net external leakage on the supply side, and outgoing net external leakage on the extract side, or vice-versa. External local short-circuiting is not illustrated here. The recirculation fractions are defined below in terms of mass flows:

$$R_s \equiv \frac{\dot{m}_{32} + \dot{m}_{Ls}^{\oplus}}{\dot{m}_2} \equiv 1 - \frac{\dot{m}_{12}}{\dot{m}_2} \quad , \quad R_e \equiv \frac{\dot{m}_{14}}{\dot{m}_4} \equiv 1 - \frac{\dot{m}_{34} + \dot{m}_{Le}^{\oplus}}{\dot{m}_4}$$



Key

1 inert tracer gas injection

2 gas measurement

Figure C.4 — Set-up for in-duct tracer gas test

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[3] EN 60335-2-40, *Household and similar electrical appliances — Safety — Part 2-40: Particular requirements for electrical heat pumps, air conditioners and dehumidifiers (IEC 60335-2-40:2002, modified)*

[4] EN 60335-2-80, *Household and similar electrical appliances — Safety — Part 2-80: Particular requirements for fans (IEC 60335-2-80:2002)*

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