BS EN 13141-4:2011

BSI Standards Publication

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

Part 4: Fans used in residential ventilation systems

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National foreword

This British Standard is the UK implementation of EN 13141-4:2011. It supersedes BS EN 13141-4:2004, which is withdrawn.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.

ISBN 978 0 580 68816 4

ICS 23.120; 91.140.30

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

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2011.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13141-4

July 2011

ICS 91.140.30

Supersedes EN 13141-4:2004

English Version

Ventilation for buildings - Performance testing of components/products for residential ventilation - Part 4: Fans used in residential ventilation systems

Ventilation des bâtiments - Essais de performance des composants/produits pour la ventilation des logements - Partie 4: Ventilateurs utilisés dans les systèmes de ventilation des logements

Lüftung von Gebäuden - Leistungsprüfungen von Bauteilen/Produkten für die Lüftung von Wohnungen - Teil 4: Ventilatoren in Lüftungsanlagen für Wohnungen

This European Standard was approved by CEN on 4 June 2011.

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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-CENELEC Management Centre has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION
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Ref. No. EN 13141-4:2011: E

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Foreword

This document (EN 13141-4:2011) 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 January 2012, and conflicting national standards shall be withdrawn at the latest by January 2012.

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 13141-4:2004.

In comparison to EN 13141-4:2004, the following changes have been made:

— in Clause 2 updating of the normative references mainly to include the revision of acoustics standards;

— in Clause 3 updating of the definitions;

— in 4.2.2.1 Figures 2 and 3 have been defined more precisely and an example of connection box for inlets on 2 opposite faces of the fan casing has been added in Figure 3 c);

— in 4.2.2.2 b) suppression of the procedure to determine the inlet to be connected;

— in 4.3 suppression of the equation to calculate the fan work per unit mass;

— addition of 4.4 Energy efficiency including Table 2 concerning part load weighting and an equation to calculate the weighted energy efficiency;

— in 5.1 change of terms;

— addition of 5.2.1 Parameters to test and test method including Table 3 concerning tests methods;

— in 5.2.3 (ex 5.2.2) suppression of the note and adding of an example of test room for category D installation in Figure 9 d);

— in 5.2.4 (ex 5.2.3) suppression of the list of standards and the sentence concerning non-ideal free field conditions;

— in 5.4 modification of the limits of the octave band for the presentation of results, addition of the list of the results that shall be specify and modification of the Table 4 (ex Table 1);

— 6.1 the points of measurement have been defined more precisely;

— in Bibliography updating of the references.

The standard is one of a series of standards on residential ventilation. The performance characteristics of the components/products for residential ventilation are given in EN 13142.

The position of this standard in the field of 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.

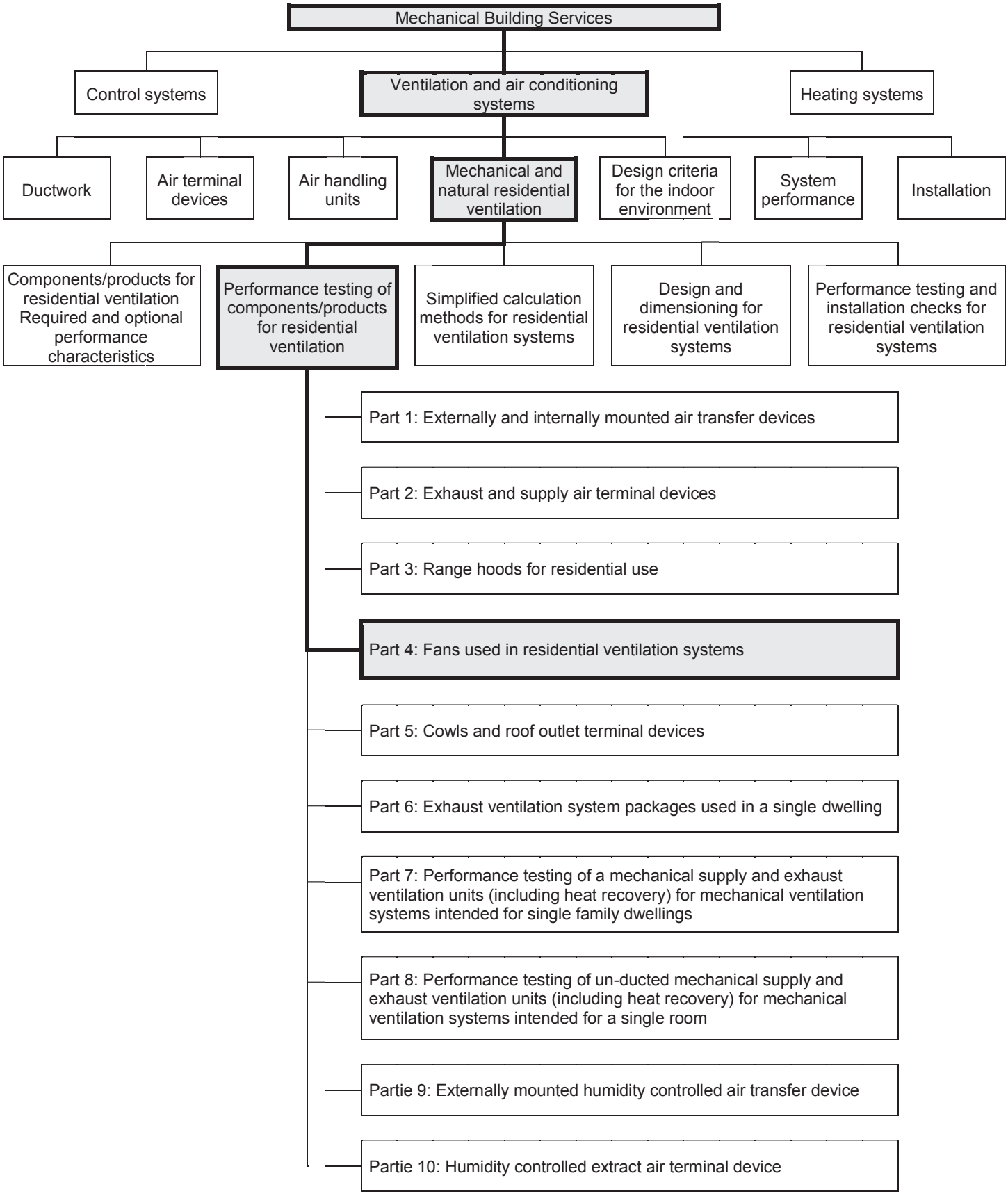


Figure 1 — Position of EN 13141-4 in the field of mechanical building services

1 Scope

This European Standard specifies aerodynamic, acoustic and electrical power performance test methods for fans used in residential ventilation. These methods primarily concern:

— ventilation fans installed on a wall or in a window without any duct;

— ventilation fans installed in the downstream of a duct;

— ventilation fans installed in the upstream of a duct;

— ventilation fans installed in a duct;

— encased ventilation fans having several inlets.

For acoustic performance testing one of the following methods is used:

— in-duct method;

— reverberant room method;

— enveloping surface method.

2 Normative references

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

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

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 5801:2008, *Industrial fans — Performance testing using standardized airways (ISO 5801:2007 including Cor 1:2008)*

ISO 13347-2, *Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 2: Reverberant room method*

ISO 13347-3, *Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 3: Enveloping surface methods*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN ISO 5801:2008 and the following apply.

3.1
fan pressure
p_F
pressure increase (in Pa) induced by the fan given as the difference of outlet and inlet total pressure

NOTE Pressure is expressed in Pascals.

3.2
fan unit
casing incorporating a fan and provided with spigots

3.3
test-voltage
voltage to be used for supplying the fan during the testing (in V)

NOTE Test voltage is expressed in Volts.

3.4
declared maximum air volume flow

$q_{vmax,d}$
maximum air volume flow corresponding to the operating range declared by the manufacturer, given for standard air conditions (20 °C, 101 325 Pa) (in m^3/s)

NOTE 1 The declared maximum air volume flow is expressed in m^3/s.

NOTE 2 $q_{vmax,d}$ is not the end point of the curve but a point declared by the manufacturer and ideally chosen for a pressure taken in the list of pref.

3.5
reference total pressure

p_{ref}
pressure set in the table of reference (see Table 1), equal or just below the pressure obtained for declared maximal air volume flow, given in total pressure (in Pa)

Table 1 — Set of reference fan total pressure p_{ref}

Total reference pressure p_{ref} Pa						
10	20	50	100	150	200	250

NOTE If the measured pressure is lower than 10 Pa, use 10 Pa.

3.6
reference air volume flow

q_{vref}
air volume flow measured during the aerodynamic test of the envelope curve (maximum setting) and corresponding to the total pressure, given for standard air conditions (20 °C, 101 325 Pa) (in m^3/s)

NOTE The reference air volume flow is expressed in m^3/s.

3.7
Demand Controlled Ventilation
DCV
method providing automatic regulation to the ventilation system dependant upon the needs of air change rates (occupancy, pollution loads, etc.) using a suitable sensor and without user intervention i.e. automatic

4 Performance testing of aerodynamic characteristics

4.1 General

The test shall be carried out in accordance with EN ISO 5801 and with 4.2 to 4.4.

4.2 Test Installation and conditions

4.2.1 General

A fan is specified to supply a given flow rate to an installation. In order to choose the appropriate fan, it is necessary to know its performance characteristics, given as the volume flow rate as a function of fan pressure.

These characteristics are strongly influenced by upstream flow conditions (velocity profile, possible presence of a swirl and wind). Downstream conditions do not usually affect the fan operation, but the nature of flow downstream from the fan, especially the swirl, can have an effect on losses in the circuit and should be taken into account during installation design.

Four categories of installations are defined in EN ISO 5801:2008:

— category A: free inlet and free outlet;

— category B: free inlet and ducted outlet;

— category C: ducted inlet and free outlet;

— category D: ducted inlet and outlet.

For each category, the standard defines the installation in the immediate proximity of the fan, as well as the position of the pressure measurement.

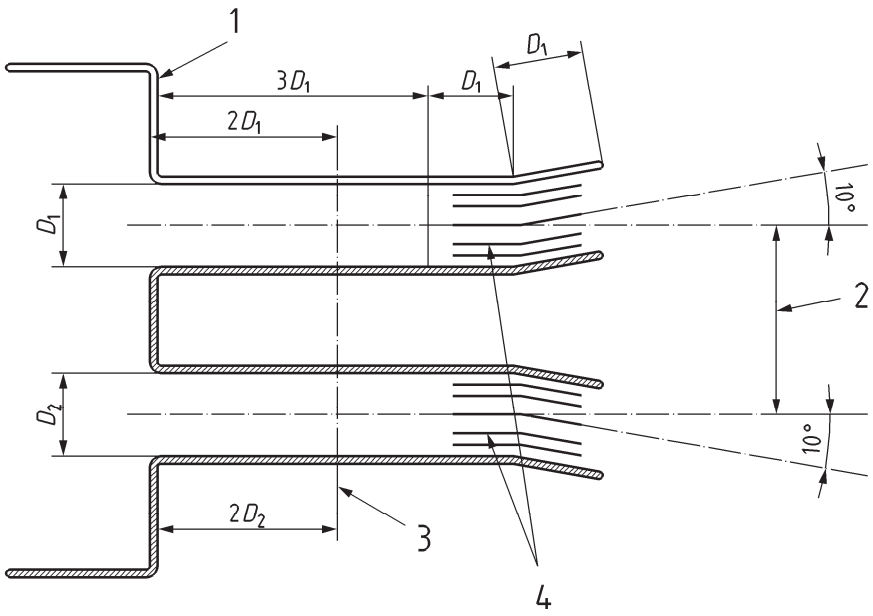
4.2.2 Exhaust fan units mounted in a casing

4.2.2.1 Test installation

This type of fan shall be mounted in casing having several inlets (all ducted) and only one outlet which discharges into the open air or into a duct.

They shall be tested using a category C or D installation, but due to the presence of more than one inlet, each inlet shall be connected to the test installation according to the category C. Where for practical reasons (insufficient distance between inlet ducts placed on the same side of casing) it is not possible to place two test installations side by side, then the arrangement shown on Figure 2 shall be applied or connection box(es) used (see Figure 3).

Special care to limit air leakages in the connection box shall be taken.



Key

1 housing wall

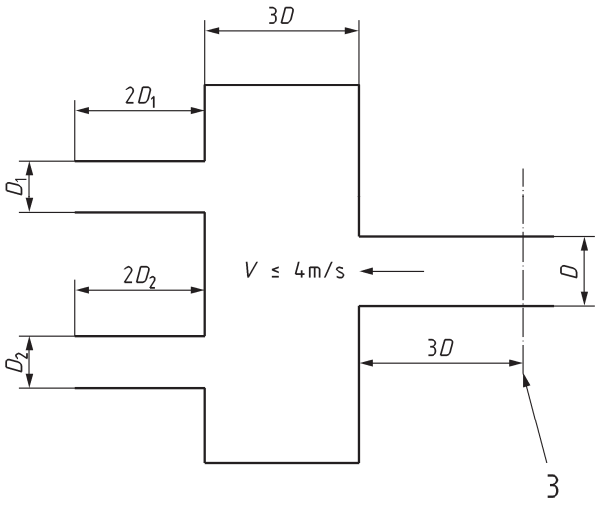
2 distance between centres

3 measuring cross-section of inlet pressure

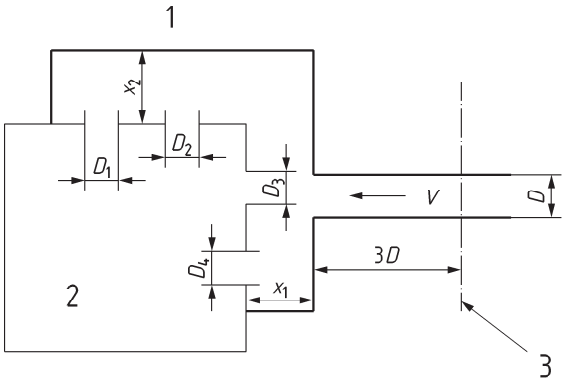
4 bladed bend placed in the duct connecting the measuring chamber to the housing orifice, the blades being sealed to the duct wall

Figure 2 — Arrangement required when the distance between centres is less than the outside diameter of the test circuit

In order to limit the number of required test installations, it is recommended to connect the inlets to a connection box (see Figure 3).



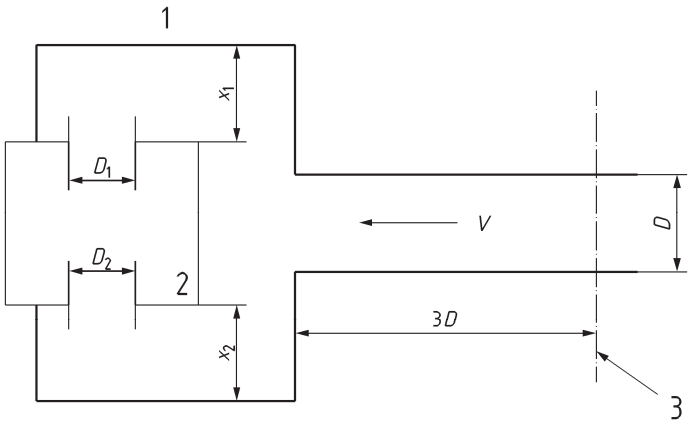
a) for all inlets on the same face of the fan casing (category C or D installation)



$x_1 \geq 3 \max (D_1, D_2 D_3, D_4)$
$x_2 \geq 3 \max (D_1, D_2, D_3, D_4)$

$$V \leq \min\left(\frac{1}{2}V_1, \frac{1}{2}V_2, \ldots, \frac{1}{2}V_i\right)$$

b) for inlets on 2 adjacent faces of the fan casing



$x_1 \geq 3\ D_1$
$x_2 \geq 3\ D_2$

$$V = \min\left(\frac{1}{2}V_1, \frac{1}{2}V_2\right)$$

c) for inlets on 2 opposite faces of the fan casing

Key

1 connection box

2 casing

3 measuring cross-section of inlet pressure

Figure 3 — Examples of connection box

4.2.2.2 Test conditions

Performance characteristics depending on the inlet flow distribution, the test shall be carried out for a minimum of two extreme conditions as follows:

a) all the inlets connected and having the same equivalent orifice;

b) one inlet connected, the other sealed.

4.2.3 Roof exhaust fans

This type of fan, normally installed at the downstream end of a duct, shall be tested using a category C or D installation.

During the test, a simulation of the roof shall be used by installing the fan in a plate with a diameter at least three times larger than the fan inlet diameter.

Fans with gravity controlled shutters shall be tested under their correct mounting conditions.

4.3 Test procedure

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 1 ~ 230 V / 3 ~ 400 V, the test voltage shall be 230 V.

This voltage shall be maintained to ± 1 % throughout the testing.

The performance characteristics of a fan used in residential ventilation shall be determined according to the following procedure:

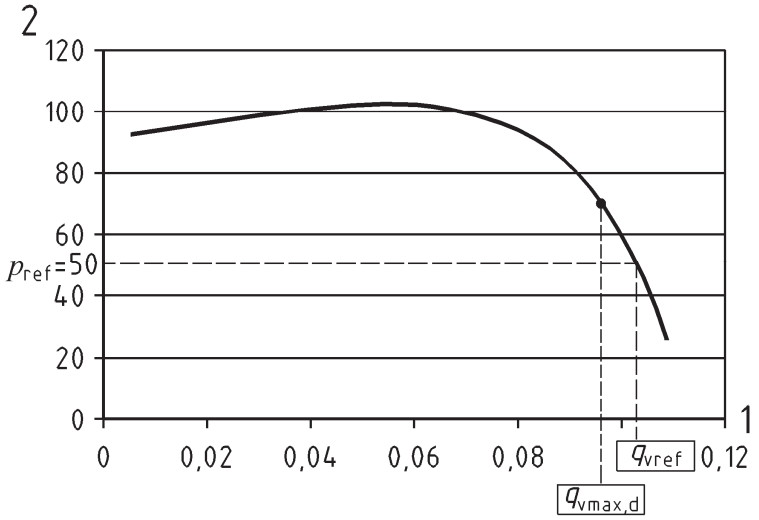
a) choose the appropriate installation category according to the intended use of the fan;

b) choose a method for flow rate measurement taking into account in particular the relatively low pressure supplied by these fans (the use of an auxiliary fan might be necessary);

c) use the simplified calculation method for fans supplying a pressure lower than 2 000 Pa with a Mach number of less than 0,15 according to EN ISO 5801:2008, 14.8.5.

4.4 Energy efficiency

The reference point (q_{vref}, p_{ref}) is defined considering the operating range of the fan and the maximum declared air volume flow, as described in Figure 4.



Key

1 x-axis: flow rate q_v expressed in m^3/s

2 y-axis: total pressure p expressed in Pa

Figure 4 — Sample of definition of the reference point q_{vref}, p_{ref}

The energy efficiency is calculated taking into account the absorbed power of the unit at its reference airflow and at intermediate flows as described in Table 2. In case of systems designed to be installed in category A (wall fans), one point only is required, at p_{ref} and q_{vref}. The absorbed power is measured during the aerodynamic test.

If there is a flow control, just use the values with this control active;

If the control is adjustable, use the default set up.

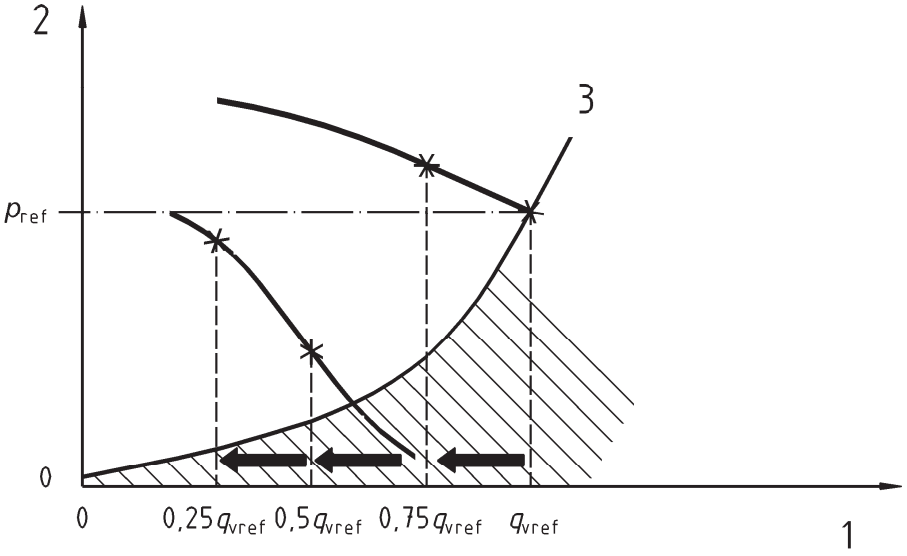
The resulting value is the energy efficiency weighted for the 3 or 4 airflows.

The application in which the fan is used has an impact on its performance. Therefore, the scenario and the weighted values are changed depending on the application intended (see Table 2).

We generally consider:

— either single speed application: the 3 points to be characterised are on this curve;

— multispeed application where the relevant points are tested according to Figure 5. In all cases, the points are on the best available speed which provides enough pressure defined from the reference duct load curve.



Key

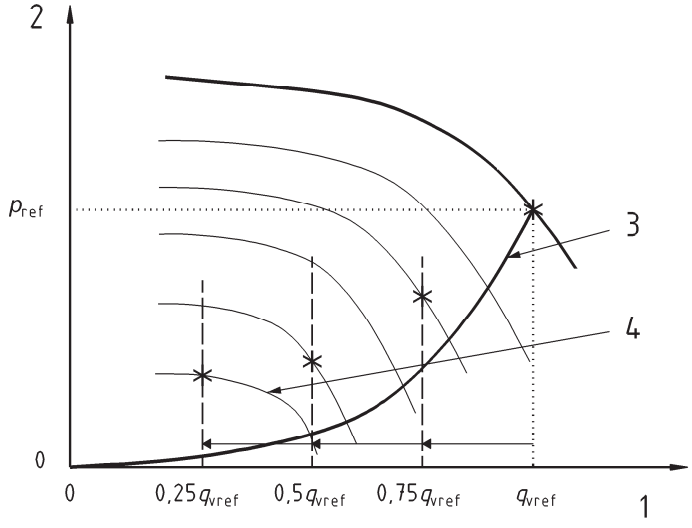
1 x-axis: flow rate q_v expressed in m^3/s

2 y-axis: total pressure p expressed in Pa

3 pressure drop curve going through the point (q_{vref}, $\boldsymbol{p_{ref}}$)

Figure 5 — Multispeed (2 speeds in the figure)

For demand control ventilation where the points can vary totally, the control adapts automatically (see Figure 6).



Key

1 x-axis: flow rate q_v expressed in m^3/s

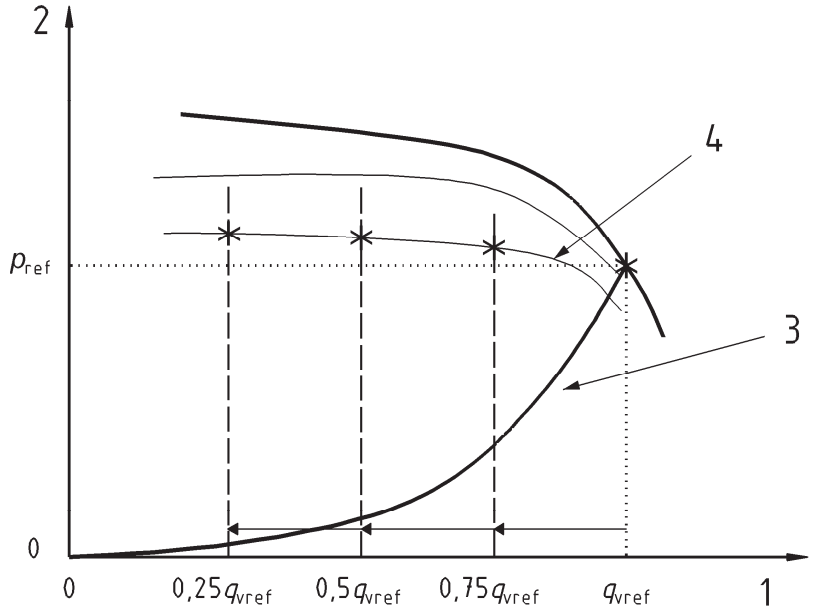
2 y-axis: total pressure p expressed in Pa

3 reference duct load curve

4 minimum control curve

Figure 6 — Example of demand control for the determination of the test points

Figure 7 shows an example of constant pressure regulation.



Key

1 x-axis: flow rate q_v expressed in m^3/s

2 y-axis: total pressure p expressed in Pa

3 reference duct load curve

4 minimum control curve

Figure 7 — Example of control with constant pressure regulation for the determination of the test points

Table 2 — Values of occurrence frequencies F_i for part load weighting

Values in percentage

Application	**Value of part load of reference air volume flow** x_i			
	25	**50**	**75**	**100**
On/off	—	—	—	100
Fixed – 1 speed	—	30	40	30
Fixed – 2 or 3 speeds	10	30	30	30
DCV	40	30	20	10

Values given in Table 2 shall be used for labelling only and not for calculation or design.

Then, the weighted energy efficiency (EEw) shall be calculated by using the following equation:

$$EEw = \frac{q_{vref} \times \Delta p_{ref} \times \sum_i \left(F_i \times x_i\right)}{\sum_i \left(F_i \times P_i\right)}$$

where

P_i is the electrical power (in W) measured at $q_{vi} = x_i \times q_{vref}$

4.5 Presentation of results

Fan performance characteristics shall be presented according to EN ISO 5801.

5 Performance testing of acoustic characteristics

5.1 General

The sound power radiated by a fan, like its performance characteristics, is influenced by the presence of ducting on the inlet or outlet side. Four installation categories are defined: A, B, C and D (see 4.2.1).

The inlet (or outlet) fan sound power found in each of these four standardized installation conditions may be different, whilst the fan inlet sound power and the fan outlet sound power may also be found to be different for any given installation category. It is therefore necessary to define for each type of fan which sound power shall be determined.

One of the following test methods shall be used according to the type of the installation:

a) in-duct method;

b) reverberant room method;

c) enveloping surface method.

5.2 Test Installation and conditions

5.2.1 Parameters to test and test method

Depending on the installation category, different acoustic parameters may be measured, each of them by different test methods described in Table 4. Some methods allow to determine them independently, some not.

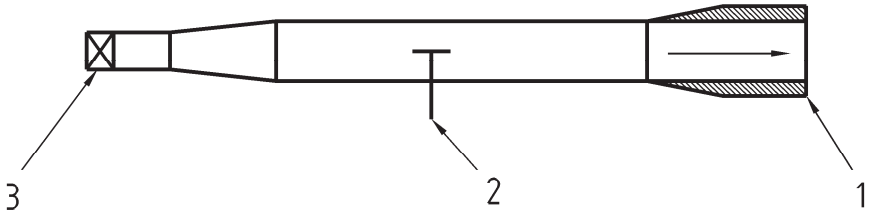
Table 3 — Test methods to measure acoustic characteristics

Installation category	Parameters	Possible test methods	Sub clause
A	Free inlet sound level	Reverberant room Enveloping surface	5.2.3 Figure 9 b) 5.2.4
	Free outlet sound level	Reverberant room Enveloping surface	5.2.3 Figure 9 b) 5.2.4
	Both	Reverberant room Enveloping surface	5.2.3 Figure 9 a) 5.2.4
B	Free inlet sound level	Reverberant room Enveloping surface	5.2.3 Figure 9 c) 5.2.4
	Ducted outlet sound level	In-duct method Enveloping surface	5.2.2 Figure 8 a) 5.2.4
C	Free outlet sound level	Reverberant room Enveloping surface	5.2.3 Figure 9 c) 5.2.4
	Ducted inlet sound level	In-duct method Enveloping surface	5.2.2 Figure 8 b) 5.2.4
D	Ducted inlet sound level	In-duct method Enveloping surface	5.2.2 Figure 8 c) 5.2.4
	Ducted outlet sound level	In-duct method Enveloping surface	5.2.2 Figure 8 c) 5.2.4
	Noise radiated by the casing	Reverberant room	5.2.3 Figure 9 d)

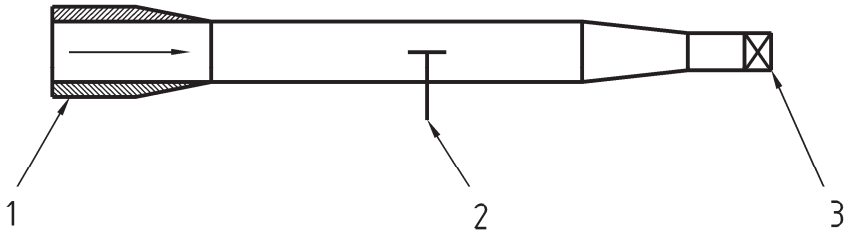
5.2.2 In-duct method

The in-duct method as given in EN ISO 5136 shall be used to determine the sound power radiated into a duct on the inlet and outlet side of the fan, and shall be therefore applied for testing with installations categories B, C and D (see Figure 8).

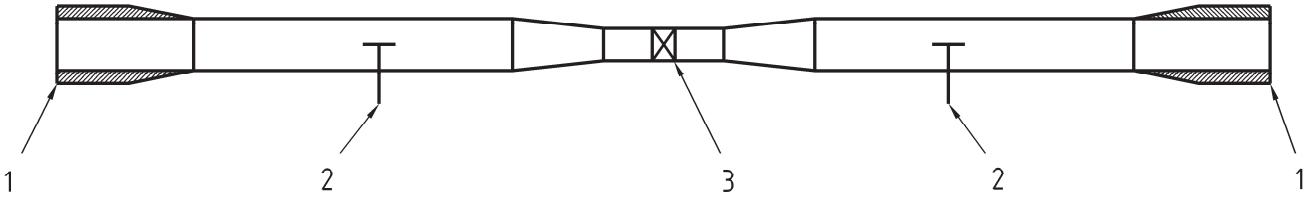
For category D (see Figure 8 c)) either two anechoic terminations may be used, with simultaneous measurement on both sides of the fan, or a single anechoic termination may be fitted successively on only one side, the second side being connected to a duct with a muffler.



a) In-duct method for category B installation



b) In-duct method for category C installation



c) In-duct method for category D installation

Key

1 anechoic termination

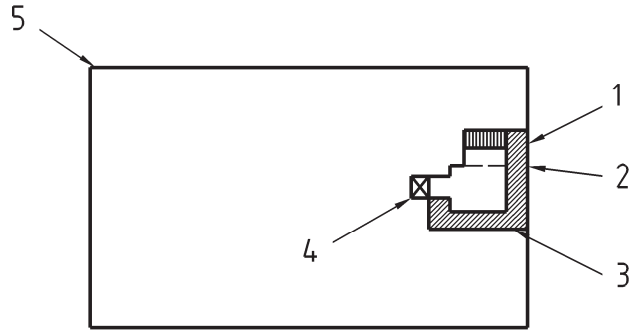
2 measurement

3 fan

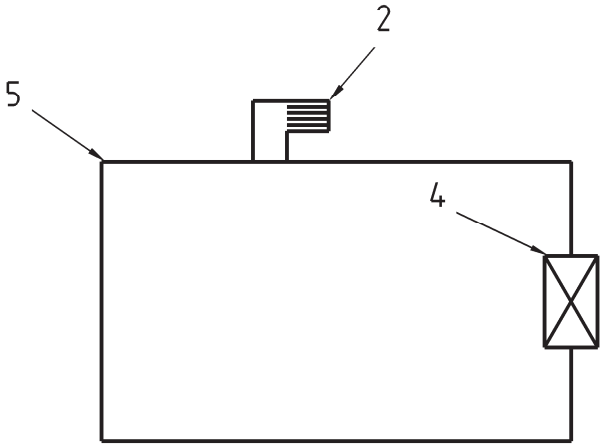
Figure 8 — In-duct method

5.2.3 Reverberant room method

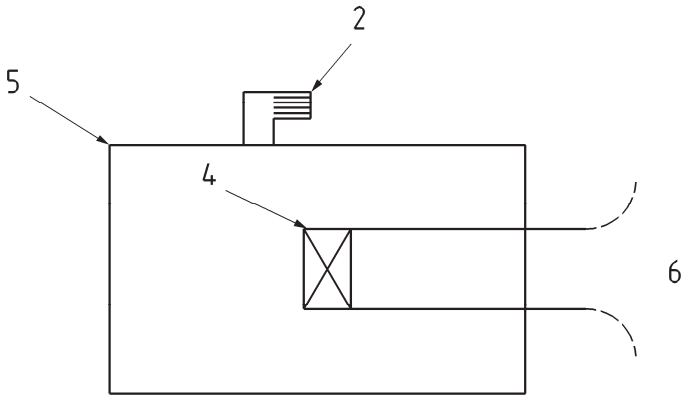
The reverberant room method as given in ISO 13347-2 shall be used to determine the sound power radiated by free inlet in categories A and B installations and by free outlet in categories A and C installations (see Figure 9). The air circuit may be within the reverberant room or outside.



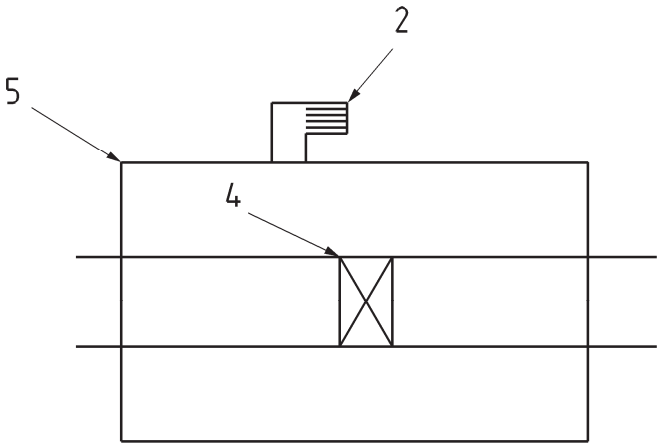
a) with the whole air circuit within the room



b) with category A installation



c) with categories B and C installation



d) for measuring break-out noise with category D installation

Key

1 attenuator
2 flow control and measurement
3 sound absorption
4 fan
5 reverberant room
6 anechoic termination for category B or fan inlet for category C

Figure 9 — Reverberant room method: test rooms

5.2.4 Enveloping surface method

The enveloping surface method as given in ISO 13347-3 shall be used for the determination of open inlet and open outlet sound power of fans for categories A, B and C installations, and also for fans too small for testing by the in-duct method.

5.3 Test procedure

The method specified in 5.2 shall be used to determine the sound power level for each setting and each time at least three operating points for which the fan aerodynamic performance characteristics have been determined, including the two extreme working air flows.

5.4 Presentation of results

The test installation and conditions shall be clearly described. All measured and analysed data shall be presented in accordance with Table 4 (one table for each operating point within each setting).

The results shall be presented in all the octave bands from 63 Hz to 8 000 Hz in addition to the overall A-weighted sound power level.

NOTE It should be noted that the uncertainties given in ISO 13347 (all parts) below 100 Hz one-third octave band (or 125 Hz octave band) can only be achieved by instruments having good accuracy and with an appropriate test environment.

The results shall specify:

— installation category;

— fan setting;

— operating point;

— acoustic parameters measured;

— test method used for each parameter.

Table 4 — Example of presentation of the acoustic characteristic for category D installation

Installation category: D		Fan setting:			Operating point: q_v: Δ_p:	
Test methods for:						
Break-out noise:		Inlet noise:			Outlet noise:	
	Overall L_{wa}	**63 Hz** [b]	**125 Hz**	**250 Hz**	**...**	**8 000 Hz**
L_W break-out in dB [a]						
L_W duct inlet in dB [a]						
L_W duct outlet in dB [a]						
a where L_W is the sound power level of the fan b optional						

6 Performance testing of electrical power

6.1 Testing method

The electrical power of the fan shall be determined according to EN ISO 5801 for the same operating points as for the aerodynamic measurements and at least for the point (P_i, q_i) necessary for the determination of the index EEw (see 4.2). For fan units where the number of inlets connected has influence, the two extremes tested shall be reported.

That electrical power shall be used to calculate the electrical power per unit of air flow rate.

If the fan has several inlets, the energy efficiency index has to be defined when all the inlets are connected.

6.2 Presentation of results

The results shall be presented in a graph (electrical power per unit of air flow rate versus air flow rate).

7 Safety

In addition to the requirements of this document, ventilation fans shall also satisfy the safety requirements specified in EN 60335-2-80.

Bibliography

[1] ISO 13347-1, *Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 1: General overview*

[2] ISO 13347-4, *Industrial fans —Determination of fan sound power levels under standardized laboratory conditions -- Part 4: Sound intensity method*

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