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Fume cupboards
Part 6: Variable air volume fume cupboards

La norma descrive i requisiti e i metodi di prova di omologazione per i sistemi VAV. Essa specifica anche requisiti aggiuntivi a quelli della UNI EN 14175-2 e metodi di prova aggiuntivi a quelli delle UNI EN 14175-3 e UNI EN 14175-4 per cappe di aspirazione con sistemi VAV (cappe di aspirazione VAV).

TESTO I L L E

La presente norma è la versione ufficiale in lingua inglese della norma europea EN 14175-6 (edizione maggio 2006).

ICS 71.040.10

PREMESSA NAZIONALE

La presente norma costituisce il recepimento, in lingua inglese, della norma europea EN 14175-6 (edizione maggio 2006), che assume così lo status di norma nazionale italiana.

La presente norma è stata elaborata sotto la competenza dell'ente federato all'UNI

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La presente norma è stata ratificata dal Presidente dell'UNI ed è entrata a far parte del corpo normativo nazionale il 13 luglio 2006.

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English Version

Fume cupboards - Part 6: Variable air volume fume cupboards

Sorbonnes - Partie 6 : Sorbonnes à débit d'air variable

Abzüge - Teil 6: Abzüge mit variablem Luftstrom

This European Standard was approved by CEN on 3 April 2006.

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Foreword

This document (EN 14175-6:2006) has been prepared by Technical Committee CEN/TC 332 "Laboratory Equipment", the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by November 2006, and conflicting national standards shall be withdrawn at the latest by November 2006.

EN 14175 consists of the following parts, under the general title *Fume cupboards*:

- ↓ *Part 1: Vocabulary*
- ↓ *Part 2: Safety and performance requirements*
- ↓ *Part 3: Type test methods*
- ↓ *Part 4: On-site test methods*
- ↓ *Part 6: Variable air volume fume cupboards*

Part 5 (*Recommendations for installation and maintenance*) is in preparation and will be published as a Technical Specification CEN/TS 14175-5.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, 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.

Introduction

The purpose of a variable air volume (VAV) system is to control the extract volume flow rate of a fume cupboard at various sash openings.

The objective of this document is to specify test methods relevant to the assessment of the performance of variable air volume (VAV) fume cupboards (see definition in EN 14175-1, 3.5) either as a single VAV system or as a combination of fume cupboard plus VAV system.

The intention of this document is to enable a purchaser to choose his fume cupboard according to his demands and needs for containment, air exchange efficiency etc, as described in EN 14175-3. Afterwards, the purchaser can proceed with his selection of an appropriate VAV system.

1 Scope

This document specifies requirements and type test methods for VAV systems. It also specifies additional requirements to those in EN 14175-2 and additional test methods to those in EN 14175-3 and EN 14175-4 for fume cupboards with VAV systems (VAV fume cupboards).

For terms and definitions, EN 14175-1 applies. For safety and performance requirements of fume cupboards, EN 14175-2 applies. For type testing of fume cupboards with preset air volume flow, EN 14175-3 applies. For on-site test methods of fume cupboards already installed in a laboratory, EN 14175-4 applies.

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 12589:2001, *Ventilation for buildings - Air terminal units - Aerodynamic testing and rating of constant and variable rate terminal units*.

EN 14175-1:2003, *Fume cupboards - Part 1: Vocabulary*.

EN 14175-2:2003, *Fume cupboards - Part 2: Safety and performance requirements*.

EN 14175-3:2003, *Fume cupboards - Part 3: Type test methods*.

EN 14175-4:2004, *Fume cupboards - Part 4: On-site test methods*.

EN ISO 5167-1, *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 5167-1:2003)*.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14175-1:2003 and EN 14175-3:2003 and the following apply.

3.1

VAV system

modular components enabling the control of the extract volume flow rate of a fume cupboard at various sash openings

3.2

response time

time from a change of the set value, e.g. volume flow rate or face velocity, until the actual new set value reaches and maintains a specified percentage

4 Requirements

4.1 General

Variable air volume fume cupboards shall meet the requirements specified in EN 14175-2 for general purpose fume cupboards and the following requirements in this document.

4.2 System status port

Means shall be provided to indicate the status of the VAV system, such as the position of damping/regulating devices, measured and controlled values.

NOTE For electrically operated systems, this can be done for instance by providing an easily accessible electrical socket for handheld readouts.

4.3 Air flow indicator

VAV fume cupboards shall be equipped with an air flow indicator with audible and visual alarms in accordance with EN 14175-2:2003, 8.2. The visual alarm may be, for example, a red flashing light in the visual field of the fume cupboard operator. Means should be provided to relay the alarm.

NOTE General requirements for visual danger signals are given in EN 842.

5 Type test methods

5.1 General

VAV systems and VAV fume cupboards can be tested either separately in accordance with 5.3 or in combination in accordance with 5.4.

As an alternative to the tests specified in 5.3, it is possible to test the VAV system together with a fume cupboard (1) instead of the test box. Also if the tests according to 5.3 have been done, it is possible for a purchaser, user or manufacturer to test individual fume cupboards (2) according to 5.4. In both cases (1) and (2), the test results are only valid for the particular combination of VAV system and fume cupboard used.

The type test in accordance with 5.3 or 5.4 shall be performed in addition to those type test methods specified in EN 14175-3. It is necessary to test the fume cupboard at the minimum air extract flow rate at the closed sash position and to find out the effect on containment of the fume cupboard and the effect of changing the extract volume flow rate during changing the sash position by the VAV system.

5.2 Test conditions

5.2.1 VAV fume cupboards (see 5.4)

The test room shall be in accordance with EN 14175-3:2003, Clause 4, with the additional requirement that the pressure difference between the test room and adjacent rooms varies no more than ± 5 Pa.

The air flow system of the test room should be sized so that the required changes in extract volume flow rate do not cause too large changes of the static pressure in the extract duct.

5.2.2 VAV systems (see 5.3)

In the surroundings of 1 m around the test box (see 5.3.2.2), the air conditions as specified in EN 14175-3:2003, 4.2 shall prevail.

5.3 Test of VAV systems

5.3.1 General

Type testing of VAV systems not fitted to an individual fume cupboard shall be performed in association with the test box shown in Figure 1.

NOTE Basis for this type test is EN 12589.

5.3.2 Tests for air flow rate characteristics

5.3.2.1 Principle

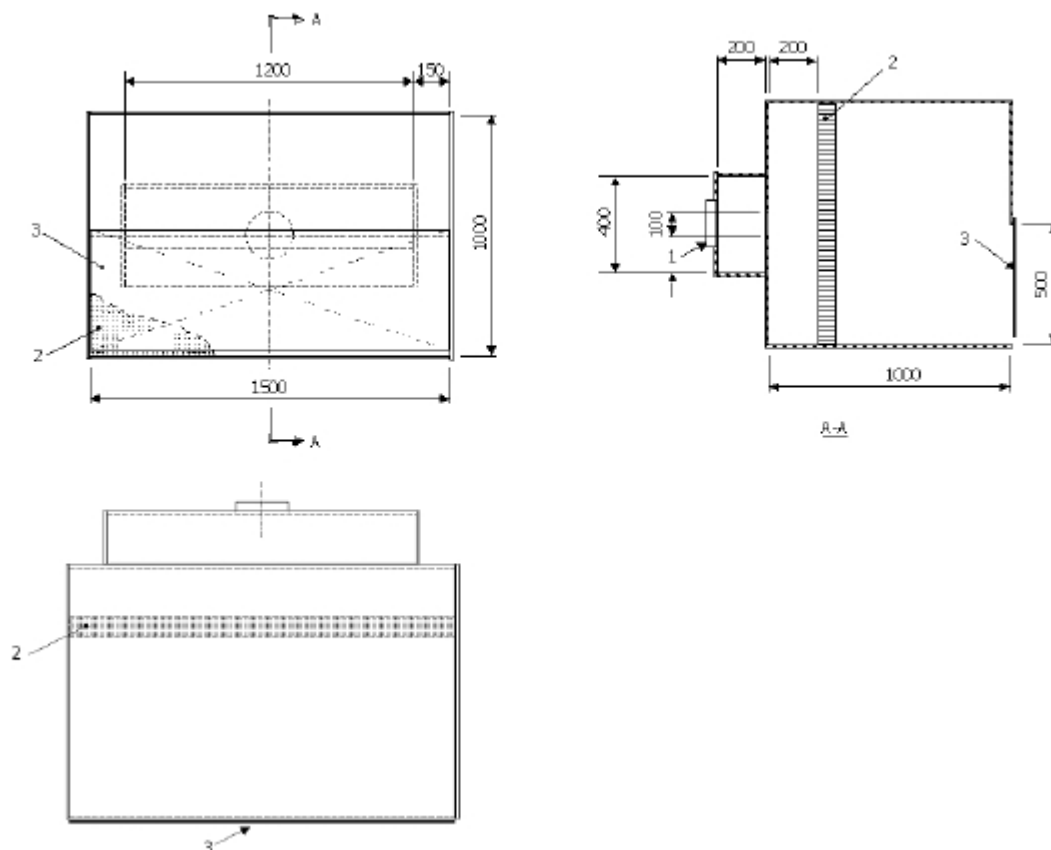
This test is to determine the changes in volume flow rate resulting from variations in the pressure difference between the surroundings and the downstream duct of the VAV, and additionally, to determine the minimum pressure difference which is necessary to reach the performance of the VAV system within the specified operating tolerances (minimum operating pressure difference).

5.3.2.2 Test equipment

Test equipment shall be in accordance with EN 12589:2001, 4.1, 4.2 and 4.3, and the test box in accordance with Figure 1. The time constants of the volume flow rate and pressure difference measuring systems shall be less than $t = 0,3$ s. The device for data recording shall enable a recording interval 0,1 s.

Non-uniform flow conditions in the inlet duct of the VAV system being tested can influence the flow rate control characteristics. Therefore the test box shown in Figure 1 shall be used for these tests. The thickness of wall elements should be 15 mm to 25 mm.

Dimensions in millimetres



Key

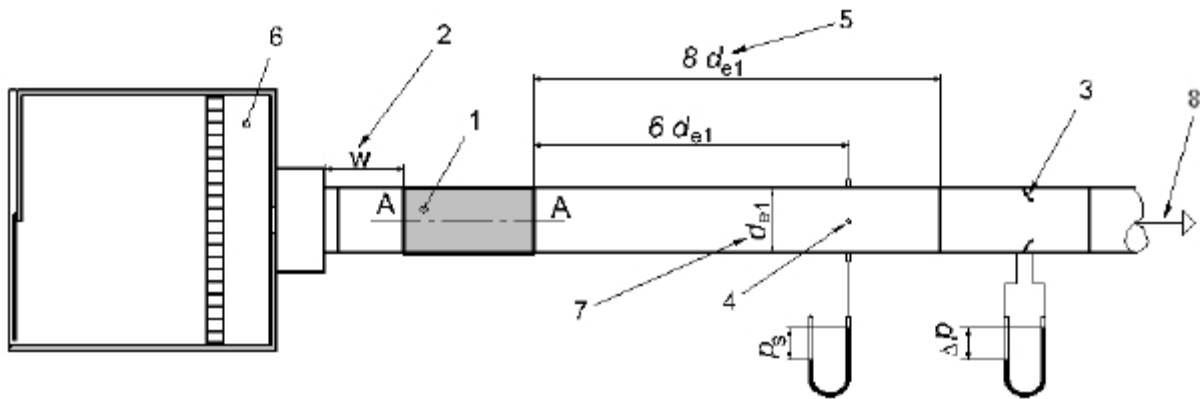
- A-A Cross section A-A
- 1 Connection location of the VAV system's ductwork
- 2 Parallel flow former with openings of 5 mm to 10 mm diameter and conforming to EN ISO 5167-1
- 3 Movable sash with a minimum opening of 25 mm and a maximum opening of 500 mm

Figure 1 — Test box

The connection of the VAV system's ductwork to the test box (see 1 in Figure 1) shall be performed in accordance with the manufacturer's instructions.

5.3.2.3 Test installation

The typical installation to determine air flow rate characteristics, dynamic control behaviour and minimum operating pressure of a VAV system is shown in Figure 2.



Key

- 1 VAV system being tested
- 2 This minimum length w to be straight and its cross section uniform and equal to that of the unit's inlet spigot. Length to be specified by the manufacturer
- 3 Flow rate measuring device conforming to EN ISO 5167-1
- 4 Pressure taps
- 5 This length to be straight and its cross section uniform and equal to that of the unit's downstream spigot
- 6 Test box in accordance with Figure 1
- 7 Equivalent diameter $d_{e1} = \sqrt{\frac{4A}{\pi}}$; A = cross sectional area of the duct
- 8 Airflow rate

Figure 2 — Typical installation

The static pressure measurement shall be performed according to EN 12589:2001, Annex A.

All parts which are functional components of the type tested VAV system shall be installed and connected in accordance with the manufacturer's instructions.

If the regulation of the VAV system is achieved by controlling fan speed, the damper may be replaced by the variable flow fan. The test procedure shall be modified in appropriate way.

5.3.2.4 Measurements to be taken

The following parameters shall be measured during the tests:

- a) P_s Downstream duct static gauge pressure
- b) ΔP Flow meter pressure difference (or the appropriate parameter that relates to the air flow rate q_v)

5.3.2.5 Test procedure

With the sash in the required position or fully open follow the test procedure given in EN 12589:2001, 5.3.1.2.1 to 5.3.1.2.4. The manufacturer shall specify the maximum and minimum pressure difference to be used in the test.

Repeat this test procedure with the VAV system under test turned 90° on axis A-A (see Figure 2).

5.3.2.6 Calculation of results

Calculation of the test results shall be done in accordance with EN 12589:2001, 5.5.1 and 5.5.2. The minimum length w shall be stated in the type test report (see 9.1).

5.3.2.7 Presentation of results

Presentation of the test results shall be done in accordance with EN 12589:2001, 5.6.

5.3.3 Tests for dynamic control behaviour**5.3.3.1 Test equipment**

In addition to the test equipment according to 5.3.2.2 a time measurement system with a time constant less than $t = 0,3$ s shall be used.

5.3.3.2 Test installation

A typical test installation is shown in Figure 2.

No additional resistance, e.g. damper or valve, except the flow rate measurement device shall be installed between the extract air fan downstream of the test installation shown in Figure 2 and the VAV system under test. No additional automatic duct pressure control system shall be installed.

The air flow system shall be sized so that the change in static pressure P_s is minimized.

NOTE An automatic duct pressure control system can influence the control characteristic of the VAV system under test.

5.3.3.3 Measurements to be taken

The following parameters shall be measured during the tests:

- a) P_s Downstream duct static gauge pressure
- b) ΔP Flow meter pressure difference (or the appropriate parameter that relates to the air flow rate q_v)
- c) t Time
- d) S Positions of the sash

5.3.3.4 Test of response time**5.3.3.4.1 General**

The air flow rate of the VAV system being tested should be at the minimum setting when the sash position has its minimum opening. At the fully open position of the sash, the air flow rate should be at the maximum setting of the VAV system under test. During the following test procedure the person performing the test shall stand to the side of the test box while opening and closing the sash.

If the VAV system being tested is combined with an air flow rate or velocity measurement system, the following tests shall be repeated with the VAV system turned 90° on axis A-A (see Figure 2).

If the VAV system being tested requires factory calibration for its operation in terms of air flow direction (horizontal or vertical), repeat the following tests with air flow straight up and down.

5.3.3.4.2 Test at maximum pressure difference

Close the sash of the test box to the minimum opening. Adjust the pressure P_s (see Figure 2) to the maximum value P_{s1} in accordance with the manufacturer's instructions. Wait until the value for the volume flow rate is within the allowable tolerance.

No other parameter, e.g. variable damper positions or fan speed than the VAV system under test shall influence the volume flow rate or the pressure of the air flow system during the test procedure.

Start the recording of the measurements.

After about 30 s ($t = 0$) open the sash to the maximum opening position within $(1 \pm 0,2)$ s.

After $t = 40$ s close the sash to the minimum opening within $(1 \pm 0,2)$ s.

After $t = 80$ s stop the recording of the measurements.

5.3.3.4.3 Test at minimum pressure difference

Open the sash of the test box to its maximum opening. Adjust the pressure P_s (see Figure 2) to the minimum value P_{s2} in accordance with the manufacturer's instructions. Wait until the value for the volume flow rate is within the allowable tolerance. Close the sash to its minimum opening.

No other parameter, e.g. variable damper positions or fan speed than the VAV system under test shall influence the volume flow rate or the pressure of the air flow system during the test procedure.

NOTE If necessary, a bypass with fixed opening(s) can be used to keep the change of the duct pressure low during the test procedure.

Start the recording of the measurements.

After about 30 s ($t = 0$) open the sash to the maximum opening position within $(1 \pm 0,2)$ s.

After $t = 40$ s close the sash to the minimum opening within $(1 \pm 0,2)$ s.

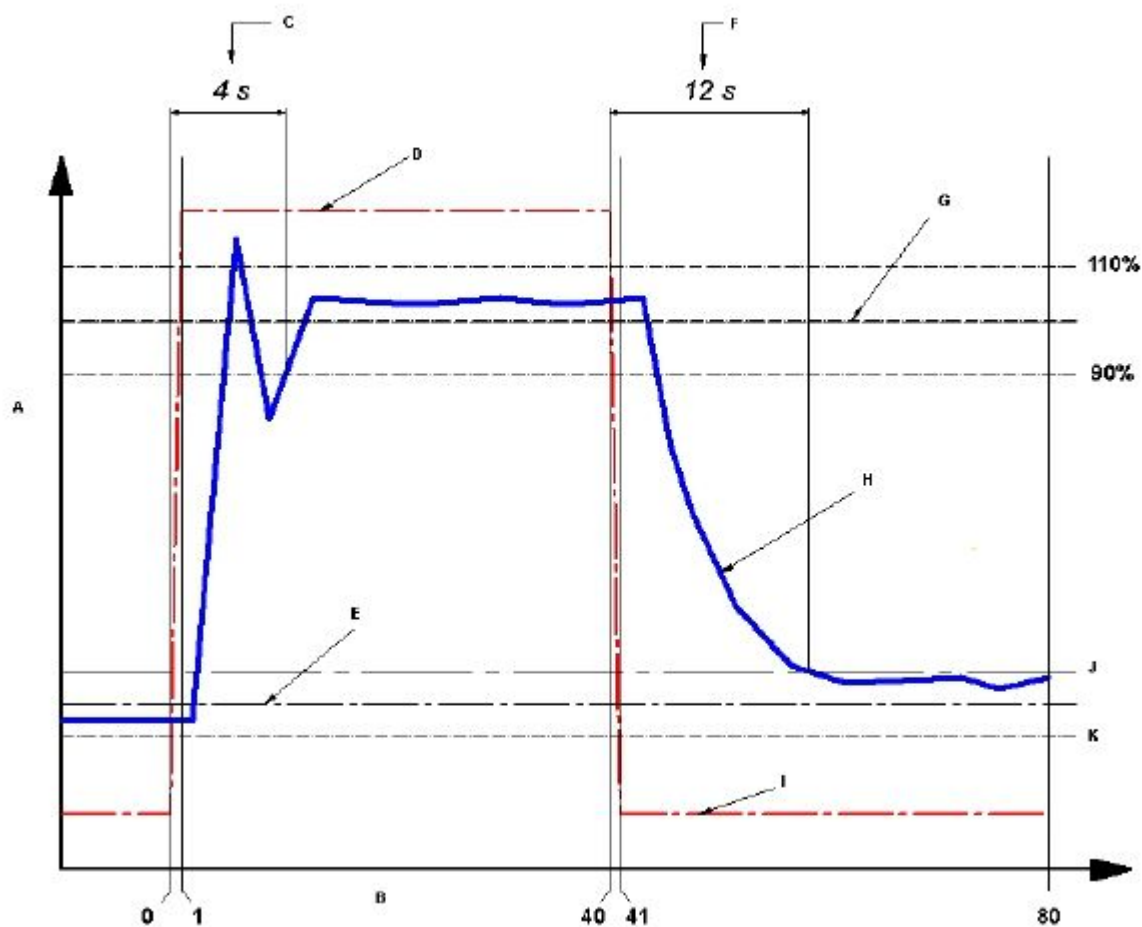
After $t = 80$ s stop the recording of the measurements.

5.3.3.5 Calculation of results

The response time is the time taken from the start of the sash movement until the air flow rate reaches and maintains, within ± 10 %, the default air flow rate specified by the manufacturer.

5.3.3.6 Presentation of results

The results of each test performed shall be presented graphically as shown in Figure 3. The pressure values P_{s1} and P_{s2} and the response time up and down shall be stated.



Key

- A Sash position, set and actual value
- B Time scale in s
- C Response time up (example)
- D Sash fully open
- E Set=minimum
- F Response time down (example)
- G Set=100 %
- H Actual value of air flow rate
- I Sash min. Open
- J min. +10 %
- K min. -10 %

Figure 3 — Example for result presentation

5.3.4 Test of set points

With the sash of the test box fully open, set the flow rate at a required value.

Measure the parameter that the VAV system uses for control (volume flow rate, velocity or pressure difference) with the sash at minimum opening, maximum opening and 50 % opening.

Compare the measured values with the set values and report the differences.

5.4 Test of VAV fume cupboards

5.4.1 Test installation

The test installation of the air flow system shall be as shown in 5.3.2.3 but with the VAV fume cupboard connected in place of the test box.

The way in which the VAV system is fitted to the fume cupboard shall be described in the test report.

5.4.2 Test of the integrated VAV system

According to 5.3. The test box shall be replaced by the fume cupboard.

5.4.3 Test of the VAV fume cupboard

5.4.3.1 Containment

The containment test at the outer measurement grid shall be performed in accordance with EN 14175-3:2003, 5.3.4 and 5.3.5.3 as follows:

- a) at the minimum pressure difference of the VAV system and the fume cupboard with the VAV system adjusted to the minimum extract volume flow rate and at the test sash opening specified by the manufacturer of the fume cupboard, and
- b) at the maximum pressure difference of the VAV system and the fume cupboard with the VAV system adjusted to the nominal extract volume flow rate specified by the manufacturer of the fume cupboard and at closed sash position.

Data analysis and results shall be according to EN 14175-3:2003, 5.3.6.2.

5.4.3.2 Air exchange at minimum volume flow rate

The test shall be performed and evaluated according to EN 14175-3:2003, 5.5 with the minimum air volume flow rate as specified by the manufacturer for the minimum sash opening.

6 On-site test methods

6.1 General

In addition to the on-site test methods specified in EN 14175-4, the following test methods are suited for the on-site testing of VAV fume cupboards.

6.2 Extract volume flow rate at set points

The extract volume flow rate shall be measured by one of the test methods specified in EN 14175-4:2004, 5.5, at the minimum opening and at 50 % of the test sash position (see EN 14175-3:2003, 4.4.2).

6.3 Test of set points

According to 5.3.4.

6.4 Test of response time

Open the sash to the test sash position and allow the flow to stabilise for 180 s. Measure the pressure drop as specified in EN 14175-4:2004, 5.6, or measure the volume flow rate as specified in EN 14175-4:2004, 5.5. Close the sash and allow the flow to stabilise for 180 s.

Open the sash in $(1 \pm 0,2)$ s to the test sash position and record the time for either the pressure drop to return to the initial value within ± 20 % or the volume flow rate to return to the initial value within ± 10 %.

6.5 Containment

According to EN 14175-4:2004, 5.10, or according to 5.4.3.1.

Calculate the mean tracer gas (SF_6) concentration in ppm for the test period from 60 s to 360 s and round the result to the second decimal place.

6.6 Air exchange at minimum volume flow rate

According to 5.4.3.2.

7 Product manual

The product information shall comply with EN 14175-2:2003, Clause 10 with additional descriptions of all VAV components including recommendations for service intervals and routine testing.

8 Marking and labelling

Marking and labelling shall comply with EN 14175-2:2003, Clause 11, including the name of the manufacturer of the fume cupboard and of the VAV system, if different.

Where appropriate, requirements for marking resulting from the machinery directive shall be observed.

9 Test reports

9.1 Type test report for VAV systems

The type test report for VAV systems shall include the following:

- a) name (or trade mark) and the address of the manufacturer;
- b) type designation of the VAV system;
- c) description of the VAV system including parameters to be specified by the manufacturer and the calibration of the VAV system;
- d) name and address of the party which carries out the tests;
- e) date of the test, signature and name of the testing person;
- f) description of the instrumentation, including its specification and calibration, and the test procedure used;
- g) description of the test room and the test conditions maintained during the tests, including air temperature and relative humidity;
- h) test sash positions employed in the tests;
- i) extract volume flow rate;

- j) results of the containment test;
- k) result of the air exchange efficiency test;
- l) diagram of the VAV system according to Figure 3;
- m) reference to this European Standard EN 14175-6:2006 and, if appropriate, any deviation.

9.2 Type test report for VAV fume cupboards

The type test report for a VAV fume cupboard shall include the following:

- a) name (or trade mark) and the address of the manufacturer;
- b) type designation of the fume cupboard;
- c) description of the fume cupboard including the external and internal dimensions, fitting, services, outlet controls, taps, sinks etc.;
- d) name and address of the party which carries out the tests;
- e) date of the test, signature and name of the testing person;
- f) description of the instrumentation, including its specification and calibration, and the test procedure used;
- g) description of the test room and the test conditions maintained during the tests, including air temperature and relative humidity;
- h) test sash positions employed in the tests;
- i) extract volume flow rate;
- j) results of the containment test;
- k) result of the air exchange efficiency test;
- l) manufacturer and type designation of the VAV system, if different from the fume cupboard manufacturer;
- m) diagram of the VAV system according to Figure 3;
- n) reference to this European Standard EN 14175-6:2006 and, if appropriate, any deviation.

9.3 On-site test report for VAV fume cupboards

The on-site test report for a VAV fume cupboard shall include the following:

- a) name (or trade mark) and the address of the manufacturer;
- b) type designation of the fume cupboard;
- c) description of the fume cupboard including the external and internal dimensions, fitting, services, outlet controls, taps, sinks etc.;
- d) name and address of the party which carries out the tests;
- e) date of the test, signature and name of the testing person;
- f) description of the instrumentation, including its specification and calibration, and the test procedure used;
- g) conditions maintained during the tests, including air temperature and relative humidity;
- h) test sash positions employed in the tests;

- i) results of the performed tests;
- j) as found data for extract volume flow rate and the finally attained extract volume flow rate after adjustment of the flow rate with the date of adjustment;
- k) manufacturer and type designation of the VAV system, if different from the fume cupboard manufacturer;
- l) diagram of the VAV system according to Figure 3;
- m) reference to this European Standard EN 14175-6:2006 and, if appropriate, any deviation.

Bibliography

- [1] EN 842, *Safety of machinery — Visual danger signals — General requirements, design and testing*

