BS EN 15726:2011

BSI Standards Publication

Ventilation for buildings — Air diffusion — Measurements in the occupied zone of air-conditioned/ventilated rooms to evaluate thermal and acoustic conditions

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 15726:2011.

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 72608 8

ICS 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 30 November 2011.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15726

October 2011

ICS 91.140.30

English Version

Ventilation for buildings - Air diffusion - Measurements in the occupied zone of air-conditioned/ventilated rooms to evaluate thermal and acoustic conditions

Systèmes de ventilation pour les bâtiments - Diffusion d'air - Mesurages dans la zone d'occupation des pièces avec conditionnement d'air ou ventilation afin d'évaluer les conditions thermiques et acoustiques

Lüftung von Gebäuden - Luftverteilung - Messungen im Aufenthaltsbereich von klimatisierten/belüfteten Räumen zur Bewertung der thermischen und akustischen Bedingungen

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

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-CENELEC 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-CENELEC 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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword

This document (EN 15726:2011) has been prepared by Technical Committee CEN/TC 156 “Vetnilation 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 April 2012, and conflicting national standards shall be withdrawn at the latest by April 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.

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.

1 Scope

This European Standard is applicable to measure some parameters of thermal and acoustic comfort (i.e. temperatures, air velocities…) in a room with an air diffusion system.

This European Standard can be used on site or in a lab for full-scale measurements.

This European Standard applies to ventilation or air conditioning systems designed to maintain the comfort conditions in buildings. It is not applicable in the case of systems for the control of industrial or other special process environments.

NOTE In the latter case however, it may be referred to if the system technology is similar to that of the above mentioned ventilation and air conditioning systems.

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 12599, *Ventilation for buildings — Test procedures and measuring methods for handing over installed ventilation and air conditioning systems*

EN 13182 *Ventilation for buildings — Instrumentation requirements for air velocity measurements in ventilated spaces*

EN 13779, *Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems*

prEN 16211, *Ventilation for buildings — Measurement of air flows on site — 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)*

EN ISO 7726, *Ergonomics of the thermal environment - Instruments for measuring physical quantities (ISO 7726:1998)*

3 Terms and definitions

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

3.1
reference point
point where the measurements are taken

3.2
mean velocity
time average velocity over the whole measuring period

3.3
spatial average velocity
average value of mean velocities taken in several points in the occupied zone

3.4
spatial maximum velocity
maximum value of mean velocities taken in several points in the occupied zone

3.5
test area
usually areas designed for human occupancy and defined as a volume of air that is confined by specified horizontal and vertical planes

NOTE 1 The vertical planes are usually parallel with the walls of the room. Usually there is also a limit placed on the height of the occupied zone. Thus, the occupied zone in a room is that space in which the occupants are normally located and where the requirements for the indoor environment shall be satisfied. Definitions are given in EN 13779:2007, 7.2.

NOTE 2 Definition of the occupied zone is dependent on the geometry and the use of the room and should be specified case by case.

[Occupied area, EN 13779, modified]

3.6
occupied zone (for laboratory purpose)
portion of the treated space geometrically limited to be no closer than 0,15 m to all walls and within a height of 1,8 m above the floor

4 Test set up and conditions

4.1 General

Before any test, the air diffusion system shall be checked accordance with EN 12599 so that its performance may be recorded.

If the system performance does not meet the design criteria, correction shall be considered prior to the continuation of the test. If this is not possible this shall be made clear in the report along with the assumptions made.

4.2 Thermal loads

The room should be occupied according to its expected use or thermal loads have to be simulated. This should include all internal and external loads (occupants, lights, equipment…). For on site measurements internal and external loads should be reported (actual or simulated).

4.3 Furniture

Furniture, curtains, absorbent surfaces, etc. can influence thermal or acoustic characteristics and should therefore be as representative as possible.

4.4 Other conditions

Operational conditions of system running (VAV, fan speed, variable geometry…) and environmental conditions do have influence on results and have to be reported according to Annex A.

Conditions must be stabilised as much as possible during the test. For instance, supply temperature and reference point temperature should be checked regularly and should not vary during the test by more than +/- 1 K. If this is not possible then the variation shall be recorded.

5 Methodology

5.1 Sampling in a room

The reference point will be situated in the centre of the test area at a height of 1,1 m. Large areas may be divided into smaller parts, usually recommended to be less than or equal to 20 m^2 (EN 12599). In this case, each smaller part shall be treated as a test area

There should be enough area to ensure a correct representation of the overall and local air diffusion. It is recommended that the test area takes into account several diffusers jets in order to cover the effect of jet interaction.

5.2 Measurements

5.2.1 General

Different levels of measurements can be used:

— Level 1: easy and quick check at the reference point(s).

— Level 2: more detailed check. Level 1 tests have to be performed first.

For each level, required measurements are indicated in Table 1.

Table 1 — Measurements required

	Level 1	**Level 2**
Airflow rate	Smoke test or any other jet visualisation (5.2.2.1)	Measurement (5.2.2.2)
Velocities		Measurement (5.2.3.2)
Temperatures	At reference point (5.2.4.2)	Measurement (5.2.4.3)
Sound pressure level	Overall dB(A) level at the reference point, or any other point where the highest sound level can be expected. (5.2.5.1)	Octave band in order to recalculate any criteria (dB(A), dB(C), NR…) asked (5.2.5.2)

If required

Ventilation Efficiency		see Annex E

5.2.2 Airflow rate

5.2.2.1 Level 1: Jet visualisation

Jet shall be visualised either by smoke test or by any other means

The objective of the visualisation is:

— to determine the air flow pattern in the occupied zone;

— to detect possible high velocity areas;

— to detect possible dead zones;

Examples of common flow patterns are given in Annex B.

5.2.2.2 Level 2: Airflow rate measurements

Any method described either in prEN 16211, EN 12599 or EN ISO 5167-1 (lab measurements) shall be used for the determination of airflow rates. Both supply and extract airflow rates shall be determined if applicable.

Results have to be compared to designed values and, if not appropriate, ventilation system shall be adjusted before continuing measurements.

5.2.3 Velocities in the occupied zone

5.2.3.1 Level 1

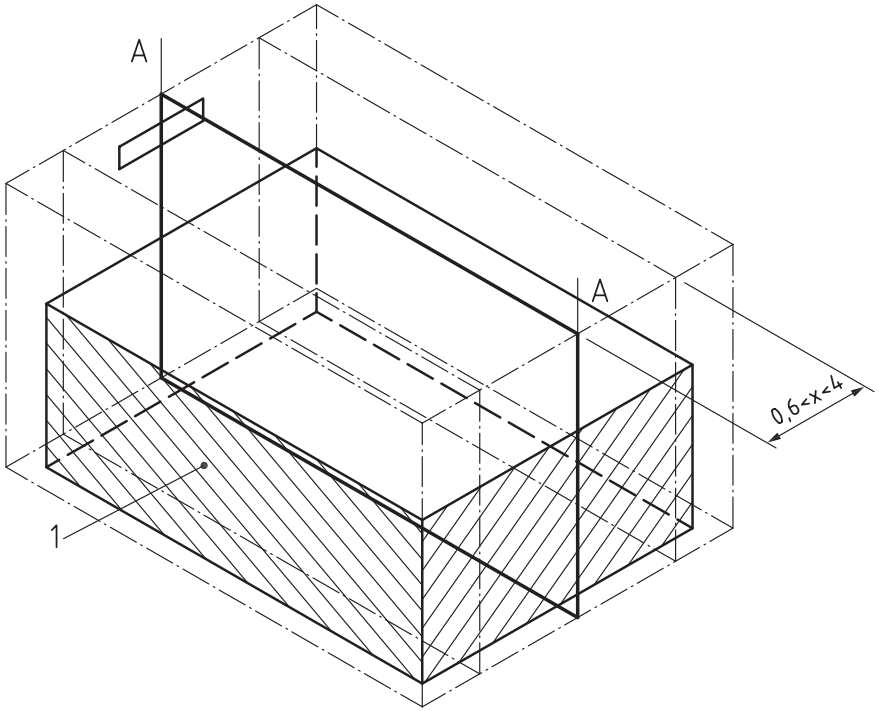
No measurements are required. Flow visualisation as in 5.2.2.

5.2.3.2 Level 2: measurements

The measurements of low velocities within treated spaces shall be made with a measuring device in accordance with EN 13182.

Air velocities should be measured in enough points in the occupied zone to determine the velocity field in the occupied zone. To this end, two or more planes of measurements shall be chosen according to Figure 1 to Figure 5. One plane has to be perpendicular to the diffuser and centred on it. Test planes must be evenly distributed in the occupied zone and spaced with a distance between 0,6 m and 4 m. They are limited by the occupied zone and shall be representative of standard occupation of the room.

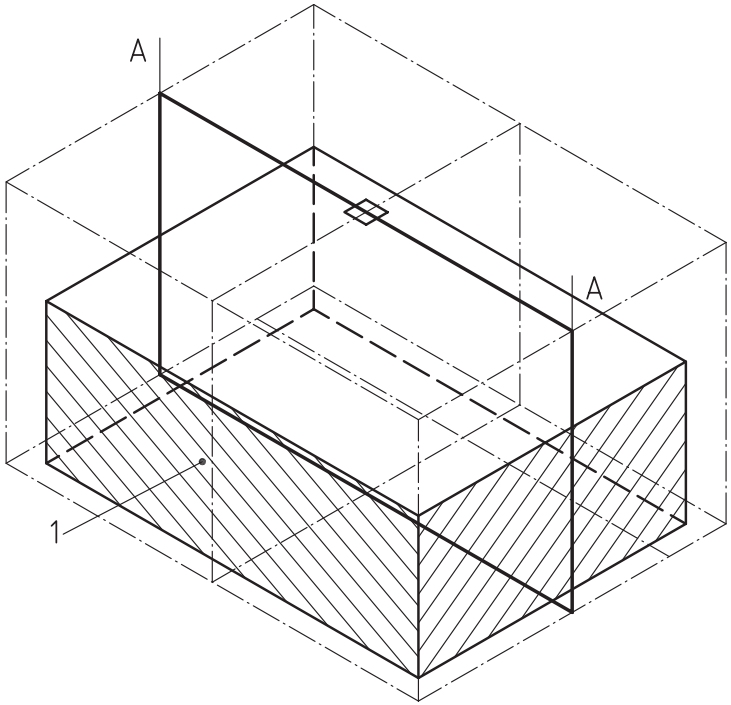
All dimensions in metres



Key

1 Occupied zone

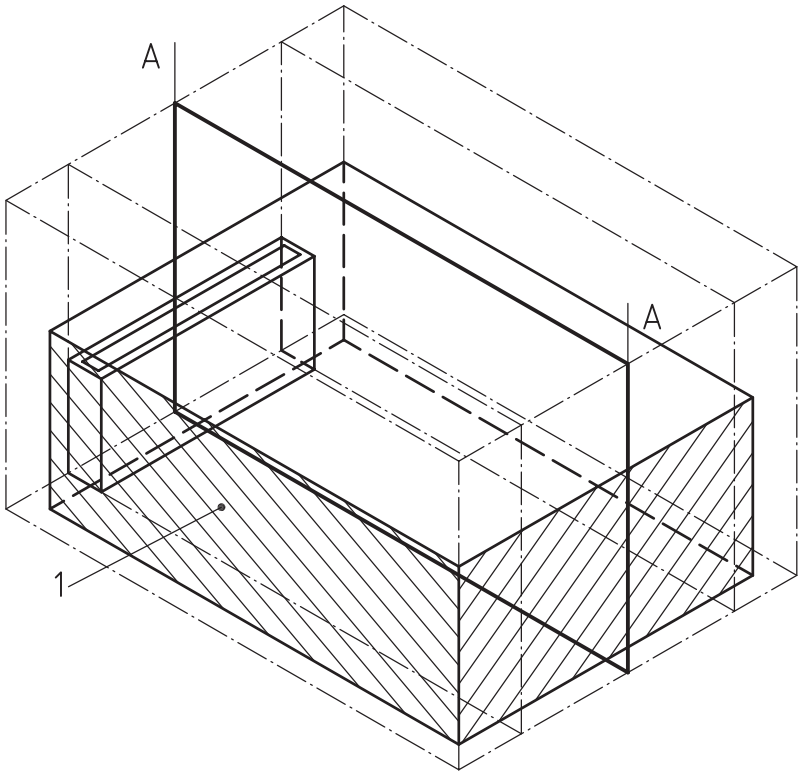
Figure 1 — Diffuser on the wall – example of test planes



Key

1 Occupied zone

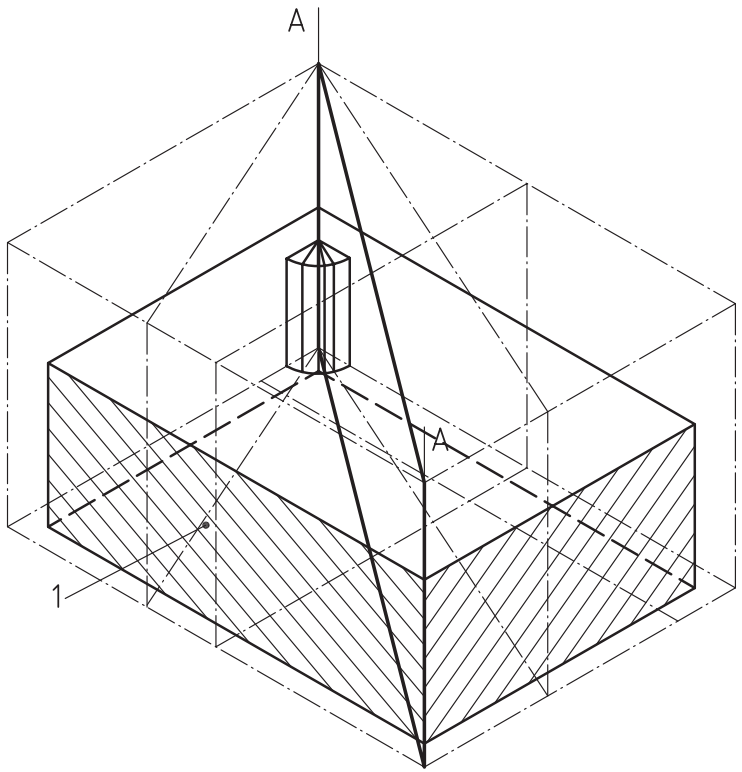
Figure 2 — Diffuser on the ceiling – example of test planes



Key

1 Occupied zone

Figure 3 — Diffuser (or fan coil) in window or floor position – example of test planes

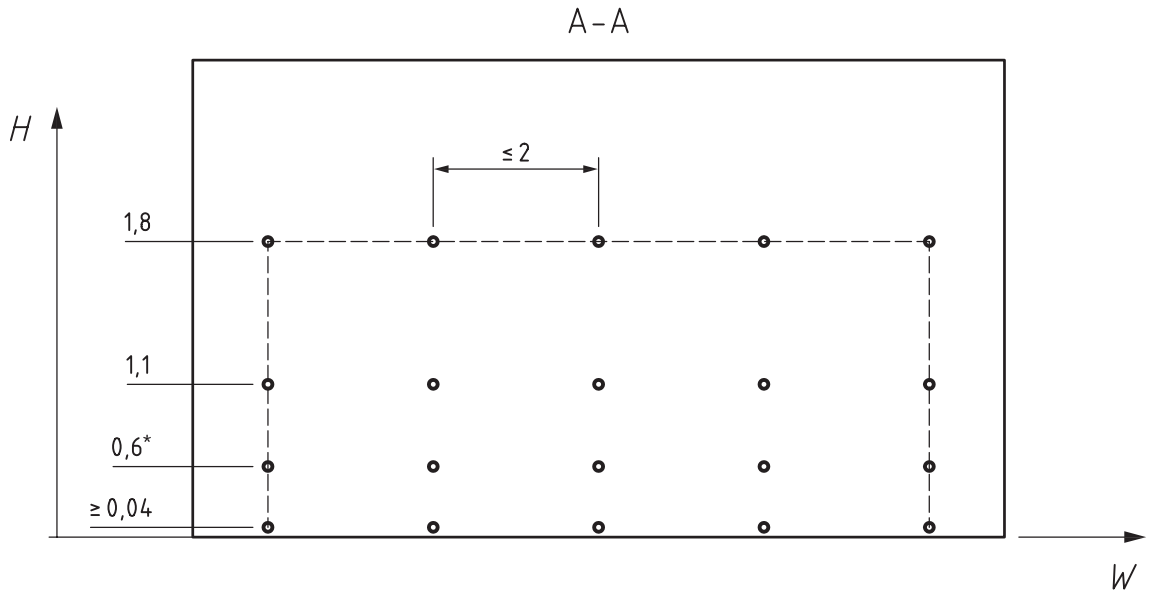


Key

1 Occupied zone

Figure 4 — Diffuser in a corner – example of test planes

All dimensions in metres



Key

W Width

H Height

* If it is necessary

Figure 5 — Distribution of points in one vertical plane

In each plane, horizontal test positions shall be evenly spaced resulting in a minimum of five positions per plane, with a maximum spacing of 2 m between them. It is recommended to have positions at the limit of the occupied zone.

In each horizontal position, velocities shall be measured at three heights from the floor. The lower and upper boundaries shall be specified in accordance with EN 13779 and additionally at 1,1 m (optional 0,6 m for seated persons). However, the lower measurement point shall not be lower than 0,04 m, If average velocity in the occupied zone is to be determined, a minimum of 15 measurement points shall be used to average the values in the occupied zone. At each point, velocity measurements shall be done according to EN 13182.

Where jet visualisation has shown highest velocities, the number of points might be increased in this zone in order to determine better the maximum air velocity in the occupied zone. These additional points should not be used for average velocity calculations.

If some positions of the described grid cannot be measured due to furniture, obstacles etc., these points should be excluded from the measurements. In this case, the position of the test planes can be slightly adapted to fit better to the occupation.

For diffusers situated in a corner, velocities should be measured as in Figure 4 in a 45º plane and, if necessary, also in the plane of maximum velocity (determined by visualisation)

Annex C gives further details on comfort analysis with regard to intermittence and draughts.

5.2.4 Temperature measurements

5.2.4.1 General

Measurements of temperatures in room shall be made by means of resistance thermometers, thermocouples or other suitable instruments as long as they are calibrated with an accuracy better than ± 0,25 K. The global accuracy shall be better or equal to ± 0,5 K.

5.2.4.2 Level 1: at reference point

The air temperature at the reference point shall be determined.

Air temperatures shall be measured by radiant shielded sensors with an accuracy better than or equal ± 0,1 K.

Globe temperature may be measured with a sensor with accuracy better than or equal ± 0,1 K, according to ISO 7726

If necessary, mean radiant temperature may be determined at the boundary of the occupied zone closest to the centre of the radiating surfaces (windows, ceiling…).

5.2.4.3 Level 2: temperature distribution

Air Temperatures shall be measured at the same points as velocities as described in 5.2.3.2 and according to ISO 7726.

If necessary, mean radiant temperature and radiant temperature asymmetry according to ISO 7726 may be determined in chosen points where occupants might be seated (1,1 m above the floor) or standing (1,7 m above the floor).

5.2.5 Sound pressure level

NOTE The following procedure is designed to be used in situ. Laboratory conditions usually differ from those found in practice.

5.2.5.1 Level 1: Overall value in a few points

The measurement shall be done at the reference point (see 5.1). In addition, other measurements should be taken to determine where the highest sound level is to be found and this reading should be recorded.

NOTE The data acquisition time for each point, when measuring, shall be adjusted to suit the local conditions (background noise e.g. traffic machinery etc)

If the measurement is in the air stream the microphone must be shielded (for instance wind shield).

In this position, the sound pressure levels in dB(A) shall be measured with the system operating normally.

Additionally, the sound pressure level in dB(A) with the system switched off shall, if possible, be measured. If the difference between system “on” and “off” is greater than 10 dB, no correction for background is required.

If this is not the case, repeat measurement when ambient noise is lower (i.e. at night)

Alternatively carry out an octave band analysis of the system “on” and “off” measurements to determine where background noise corrections are needed. This should be done at each octave band by logarithmically subtracting the background level from the system noise to obtain the true pressure level generated by the system. If this difference is less than 3 dB, the subtraction should not be done and the system noise is considered not to contribute significantly to the overall ambient noise. The corrected octave band levels with dB(A) weighting applied should then be logarithmically added together to obtain the overall dB(A) value

5.2.5.2 Level 2: Spectral analysis

In the same points of the room, a spectral analysis (octaves 63Hz to 8kHz) might be needed to determine the source of noise. This information will be needed for criteria expressed in other noise ratings (e.g. NR, NC etc.).

6 Test report

All operational and environmental data must be reported according to Annex A.

The chosen level of measurement and measurement methodology must be described.

Table 2 — Results report

	Level 1	Level 2
Airflow	Report instrumentation Visualisation of jet must be described by any means (photo, recording, short description about jet comportment...) Report air flow values for supply air	Report instrumentation. methodology, location of measuring points, results and uncertainty. Results shall be compared with design values Report air flow values for supply and extract air
Velocities		Report instrumentation, location of test planes, location of measuring points, mean velocity distribution and uncertainty, turbulence intensity if measured Spatial average and maximum value shall be reported and compared to design values when appropriate
Temperatures	Report instrumentation, location, values and uncertainty	Report instrumentation, location of test planes, location of measuring points, temperature distribution and uncertainty Average and maximum value should be reported and compared to design values when appropriate
Sound Pressure Level	Report instrumentation, location, measured value, background noise	Report instrumentation, location of measuring points, measured value of the spectrum, background noise

Annex A
(normative)

Operational and environmental conditions

Report all conditions as a checklist including sketches.

External conditions:

— building and room orientation, geographic position, date and time;

— outside temperature, wind conditions, sun conditions (shining, cloudy…);

— sun protection position.

Internal conditions:

— furniture position, curtains, absorbent surfaces…;

— position of occupants, lights, equipments, heating elements running…;

— diffuser geometry and setting and damper position;

— fan speed when variable;

— all test arrangements.

Annex B
(informative)

Typical Flow Pattern

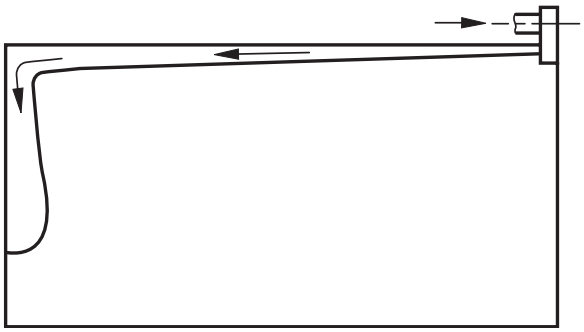


Figure B.1 — Coanda effect from wall diffuser

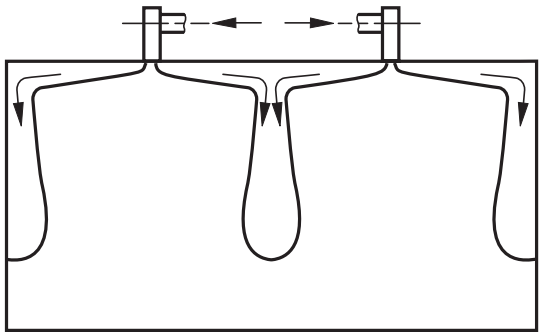
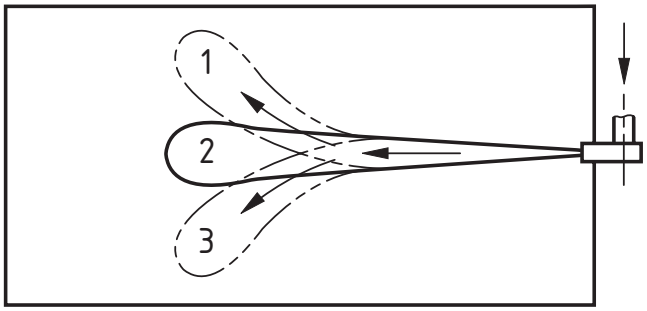
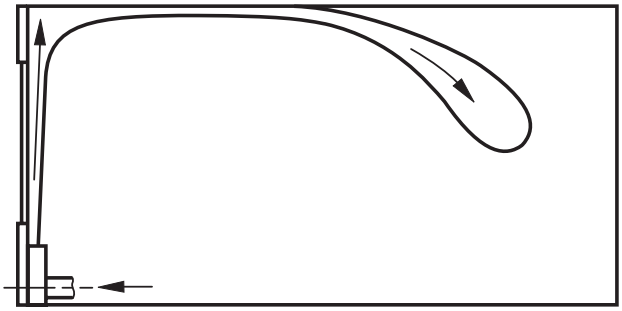


Figure B.2 — Coanda effect from ceiling





Key

1 Hot

2 Isothermal

3 Cold

Figure B.3 — Free jet

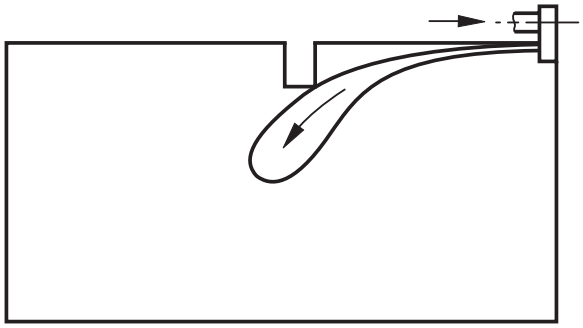
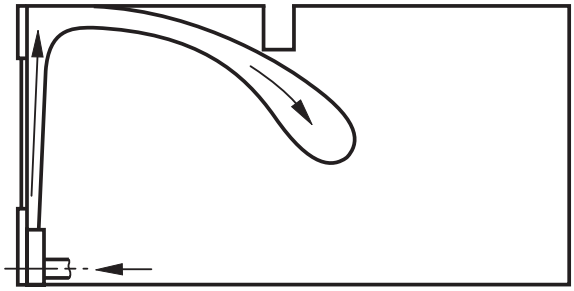


Figure B.4 — Jet from fan coil



Figures B.5 & B.6 — Examples of jet perturbation by an obstacle

Annex C
(informative)

Intermittence and draught risk

If people still complain of local discomfort and draught sensation, when different measurements (such as velocities, draught (DR) and temperatures…) are in the correct limit, the problem of intermittence has to be considered.

To assess the local air velocity conditions with respect to potential draughts at a point in the occupied zone the parameters usually considered are:

— Time average velocity (typically measured over 180 s)

— Turbulence intensity (as defined below)

Turbulence intensity:

$$Tu(\%) = \frac{S_v}{v_m} \cdot 100 \qquad \text{(C.1)}$$

S_v : standard deviation (m/s)

v_m : mean velocity (m/s)

If the measured velocity as a function of time follows a normal distribution then time average velocity and turbulence intensity can be used for comfort assessment.

However, if an acceptable combination of these parameters exists but drafts are still experienced this could be due to the “intermittence effect” i.e. local high velocities occurring in a relatively short time period which do not register significantly in the time average velocity determination.

This for example can be caused by:

— breakdown of ceiling effect;

— convection currents;

— temperature variations in supply air;

— the movement of people in the space.

Intermittence can be determined by plotting instantaneous measured values of the mean velocity into a normal distribution diagram. The measurements shall be performed at a point in the room where there are complaints of draughts. The instrumentation should be able to sort the measured values in velocity intervals, for instance:

0,00 m/s – 0,05 m/s

0,05 m/s – 0,10 m/s

0,10 m/s – 0,15 m/s

0,15 m/s – 0,20 m/s

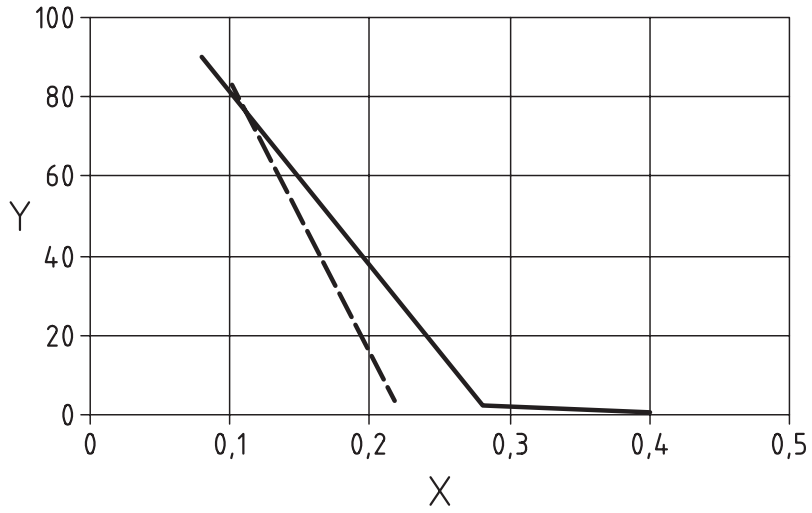
0,20 m/s – 0,25 m/s

0,25 m/s – 0,30 m/s … etc

The time percentage of the total measuring time for each interval shall be calculated and plotted into the normal distribution diagram (see Figure C.1).

If the plotted points fall on a straight line (as line A in Figure C.1), the velocities are normally distributed. The average velocity and the standard deviation totally define the line.

If the line is not straight (as line B in Figure C.1), the air current is intermittent. Often then quite high velocities can occur. Even if the occurrence time is short and the average is within acceptable limit, it can be felt as a serious draught problem.



Key

Y Time percentage/%

X Instantaneous velocity m/s

---------- line A v_m = 0,15 m/s Tu = 33 %

_____ line B v_m = 0,18 m/s intermittence

Figure C.1 — Time percentage vs instantaneous velocity

Annex D
(informative)

Estimation of Air velocities in the occupied zone for different types of jets

Calculation of velocities in jet

From ATD test (see EN 12238) we can define a range of diffusers by its constant k.

Velocities in jet can be recalculated from this characteristic

Conical or radial jet = $\frac{V_x}{V_k} = \frac{k\sqrt{A_k}}{x}$ (D.1)

where:

A_k: effective area (k factor area) (A_k) = q/V_k

x: distance from ATD (m)

v_x: velocity at distance x (m/s)

v_k: effective velocity $(V_k) = \frac{q}{A_k}$ (m/s)

q: volume flow rate (m^3/s)

Plane jet: $\frac{V_x}{V_k} = k.\sqrt{\frac{h_k}{x}}$ (D.2)

where:

h_k: effective height (m)

x: distance from ATD (m)

v_x: velocity at distance x (m/s)

NOTE 1 These formulas can be used both for plane free or adherent jet but the constant k varies for the same ATD in both cases.

NOTE 2 Velocity in the occupied zone depends on the kind of jet and room size. It is generally accepted that the average velocity in the occupied zone is 1,5 to 2,5 times lower than terminal velocity in jet. A more precise value can be obtained by tests.

Annex E
(informative)

Ventilation Efficiency Measurement

Air Change Efficiency:

$$\varepsilon_{\mathrm{r}} = \frac{\tau_{\mathrm{n}}}{2\tau_{\mathrm{m}}} \cdot 100 \qquad \text{(E.1)}$$

with τ_n = 1/n = nominal time constant

(n represents the necessary time in hours to change all the air in the room)

τ_m = average age of air in hours in the measuring point

Mean Ventilation Efficiency:

$$\varepsilon_{\mathrm{vm}} = \frac{C_{\mathrm{e}} - C_{\mathrm{s}}}{C_{\mathrm{r}} - C_{\mathrm{s}}} \cdot 100 \qquad \text{(E.2)}$$

with *C* concentrations of tracer gas in air (they have to be expressed with the same unit)

ε stands for exhaust air

e stands for extract air

s stands for supply air

r stands for air of the room

Ventilation Efficiency is measured by tracer gas

Bibliography

David Etheridge, Mats Sandberg, *Building Ventilation: Theory and Measurement,.* ISBN: 0-471-96087-X, April 1996, 754 pages (in English)

Eimund Skaaret: Handbook 48, *Ventilation Technique*,. ISBN:82-536-0714-8, NBI, Norway 2000, 220 pages (in Norwegian)

NS 8175 *Sound conditions in buildings - Sound classes for various types of buildings*, 1997 (in Norwegian)

EN 12238, *Ventilation for buildings - Air terminal devices - Aerodynamic testing and rating for mixed flow application*

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

EN 15251, *Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics*

EN ISO 7730, *Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (ISO 7730:2005)*

EN ISO 10052:2004, *Acoustics - Field measurements of airborne and impact sound insulation and of service equipment sound - Survey method (ISO 10052:2004+A1:2010)*

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™