# SVENSK STANDARD
# SS-EN 16211:2015

Fastställd/Approved: 2015-07-05
Publicerad/Published: 2015-07-06
Utgåva/Edition: 1
Språk/Language: engelska/English
ICS: 17.120.10; 91.140.30

SWEDISH STANDARDS INSTITUTE

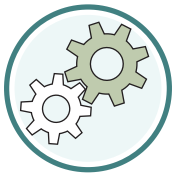
## Luftbehandling – Fältmetoder för mätning av luftflöden

## Ventilation for buildings – Measurement of air flows on site – Methods

# Standarder får världen att fungera

*SIS (Swedish Standards Institute) är en fristående ideell förening med medlemmar från både privat och offentlig sektor. Vi är en del av det europeiska och globala nätverk som utarbetar internationella standarder. Standarder är dokumenterad kunskap utvecklad av framstående aktörer inom industri, näringsliv och samhälle och befrämjar handel över gränser, bidrar till att processer och produkter blir säkrare samt effektiviserar din verksamhet.*

**Delta och påverka**
Som medlem i SIS har du möjlighet att påverka framtida standarder inom ditt område på nationell, europeisk och global nivå. Du får samtidigt tillgång till tidig information om utvecklingen inom din bransch.



**Ta del av det färdiga arbetet**
Vi erbjuder våra kunder allt som rör standarder och deras tillämpning. Hos oss kan du köpa alla publikationer du behöver – allt från enskilda standarder, tekniska rapporter och standard-paket till handböcker och onlinetjänster. Genom vår webbtjänst e-nav får du tillgång till ett lättnavigerat bibliotek där alla standarder som är aktuella för ditt företag finns tillgängliga. Standarder och handböcker är källor till kunskap. Vi säljer dem.

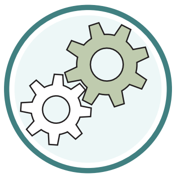
**Utveckla din kompetens och lyckas bättre i ditt arbete**
Hos SIS kan du gå öppna eller företagsinterna utbildningar kring innehåll och tillämpning av standarder. Genom vår närhet till den internationella utvecklingen och ISO får du rätt kunskap i rätt tid, direkt från källan. Med vår kunskap om standarders möjligheter hjälper vi våra kunder att skapa verklig nytta och lönsamhet i sina verksamheter.

**Vill du veta mer om SIS eller hur standarder kan effektivisera din verksamhet är du välkommen in på www.sis.se eller ta kontakt med oss på tel 08-555 523 00.**

# Standards make the world go round

*SIS (Swedish Standards Institute) is an independent non-profit organisation with members from both the private and public sectors. We are part of the European and global network that draws up international standards. Standards consist of documented knowledge developed by prominent actors within the industry, business world and society. They promote cross-border trade, they help to make processes and products safer and they streamline your organisation.*

**Take part and have influence**
As a member of SIS you will have the possibility to participate in standardization activities on national, European and global level. The membership in SIS will give you the opportunity to influence future standards and gain access to early stage information about developments within your field.



**Get to know the finished work**
We offer our customers everything in connection with standards and their application. You can purchase all the publications you need from us - everything from individual standards, technical reports and standard packages through to manuals and online services. Our web service e-nav gives you access to an easy-to-navigate library where all standards that are relevant to your company are available. Standards and manuals are sources of knowledge. We sell them.

**Increase understanding and improve perception**
With SIS you can undergo either shared or in-house training in the content and application of standards. Thanks to our proximity to international development and ISO you receive the right knowledge at the right time, direct from the source. With our knowledge about the potential of standards, we assist our customers in creating tangible benefit and profitability in their organisations.

**If you want to know more about SIS, or how standards can streamline your organisation, please visit www.sis.se or contact us on phone +46 (0)8-555 523 00**

Europastandarden EN 16211:2015 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 16211:2015.

The European Standard EN 16211:2015 has the status of a Swedish Standard. This document contains the official English version of EN 16211:2015.



*Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.*

*Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.*

Denna standard är framtagen av kommittén för Ventilation, SIS/TK 170/AG 3.

Har du synpunkter på innehållet i den här standarden, vill du delta i ett kommande revideringsarbete eller vara med och ta fram andra standarder inom området? Gå in på www.sis.se - där hittar du mer information.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 16211

July 2015

ICS 17.120.10; 91.140.30

English Version

# Ventilation for buildings - Measurement of air flows on site - Methods

Systèmes de ventilation pour les bâtiments - Mesurages de débit d'air dans les systèmes de ventilation - Méthodes

Lüftung von Gebäuden - Luftvolumenstrommessung in Lüftungssystemen - Verfahren

This European Standard was approved by CEN on 5 March 2015.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**



Ref. No. EN 16211:2015 E

# Contents

Page

# Foreword

This document (EN 16211:2015) 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 2016, and conflicting national standards shall be withdrawn at the latest by January 2016.

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.

Measurement methods which are both correct and easy to use are developed and standardized to enable the commissioning and operational monitoring of air processing installations. Interior climate and air quality can often be improved considerably if the heating and ventilation system is managed in a way that ensures good functioning in the long term. It is thus important that the system is designed and constructed to allow measurement and monitoring to be performed using established and approved methods.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# 1 Scope

This European Standard specifies simplified methods for the measurement of air flows on site. It provides a description of the air flow methods and how measurements are performed within the margins of stipulated method uncertainties.

One measurement method is to take point velocity measurements across a cross-section of a duct to obtain the air flow. This simplified method is an alternative to the method described in ISO 3966 and EN 12599. This European Standard requests certain measurement conditions (length of straight duct and uniform velocity profile) to be met to achieve the stipulated measurement uncertainties for the simplified method.

# 2 Normative references

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

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

EN 14277, *Ventilation for buildings — Air terminal devices — Method for airflow measurement by calibrated sensors in or close to ATD/plenum boxes*

# 3 Terms, definitions and symbols

## 3.1 Terms and definitions

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

## 3.2 Symbols

The following symbols are used.

| Symbol | Description | SI Unit | Symbol | Description | SI Unit |
|---|---|---|---|---|---|
| $t$ | Time | s | $O$ | Perimeter | m |
| $\rho$ | Density | kg/m$^3$ | $p$ | Pressure | Pa |
| $\rho_s$ | Standard conditions air density = *1,2* | kg/m$^3$ | $p_d$ | Dynamic pressure | Pa |
| $\rho_r$ | Real density | kg/m$^3$ | $p_s$ | Static pressure | Pa |
| $\rho_{\vartheta\ \mathrm{tracer}}$ | Tracer gas density | kg/m$^3$ | $p_t$ | Total pressure | Pa |
| $\rho_{\vartheta\ \mathrm{duct}}$ | Duct air density | kg/m$^3$ | $p_u$ | Measured pressure | Pa |
| $A$ | Cross-section Area | m$^2$ | $\Delta p$ | Differential pressure | Pa |
| $a$, $b$, $c$, etc. | Dimensions of length | mm | $\Delta p_u$ | Measured differential pressure | Pa |
| $L$ | Mixing length | mm | $q$ | Air flow | m$^3$/s, l/s |
| $H$ | Height of duct | mm | $q_k$ | Corrected air flow | m$^3$/s, l/s |
| $W$ | Width of duct | mm | $q_s$ | Tracer gas flow | m$^3$/s, l/s |
| $B$ | Barometric pressure | hPa | $q_{s\vartheta\mathrm{duct}}$ | Tracer gas flow at duct temperature | m$^3$/s, l/s |
| $C$ | Contaminant concentration | ppm | $q_{\mathrm{stracer}}$ | Tracer gas flow at rotameter temperature | m$^3$/s, l/s |
| $C_i$ | Initial tracer gas concentration | ppm | $q_t$ | Total air flow | m$^3$/s, l/s |
| $C_s$ | Tracer gas concentration in stationary condition | ppm | $q_u$ | Measured air flow | m$^3$/s, l/s |
| $D$ | Diameter | mm | $\vartheta$ | Temperature | °C |
| $D_h$ | Hydraulic diameter | mm | $\vartheta_{\mathrm{duct}}$ | Temperature in duct | °C |
| $k_c$ | coverage factor | - | $\vartheta_{\mathrm{tracer}}$ | Temperature of tracer gas | °C |
| $k_1$ | Correction factor for density | - | $V$ | Volume | m$^3$ |
| $k_2$ | Correction factor for duct shape | - | $v$ | Air velocity | m/s |
| $k$ | Flow factor | - | $v_s$ | Standard air velocity | m/s |
| $L_1$ | Smaller dimension of a rectangular duct | mm | $v_r$ | Real air velocity | m/s |
| $L_2$ | Larger dimension of a rectangular duct | mm | $v_m$ | Air velocity, mean value | m/s |
| $u_1$ | Standard Instrument uncertainty | - | | | |
| $u_2$ | Standard Method uncertainty | - | | | |
| $u_3$ | Standard Reading uncertainty | - | | | |
| $u_m$ | Standard measurement uncertainty | - | | | |
| $U_m$ | Expanded measurement uncertainty | - | | | |

# 4 Principles and parameters of influence

## 4.1 Hydraulic diameter

The hydraulic diameter is the diameter of a circular duct which causes the same pressure drop at equal air velocity and equal friction coefficient, and is defined by the following formula:

$$D_h = 4 \cdot A/O \tag{1}$$

For a rectangular duct this becomes:

$$D_h = 2 \cdot L_1 \cdot L_2 / (L_1 + L_2) \tag{2}$$

where

$L_1$ and $L_2$ are the sides of the duct.

For a circular duct this becomes:

$$D_h = D \tag{3}$$

## 4.2 Flow disturbances

Flow disturbances in ducts result in irregular velocity profiles.

NOTE Flow seldom has a symmetrical appearance except after long straight sections. The symmetry is often disturbed by varying resistance, for example after a bend, an area decrease or an area increase. The velocity profile also becomes disturbed by a damper and T-piece as well as before and after a fan.

## 4.3 Air density, $\rho$

The density of dry air varies with air pressure and temperature in accordance with the following approximating formula:

$$\rho = 1,293 \cdot \frac{B}{1013,25} \cdot \frac{273,15}{273,15 + \vartheta} \tag{4}$$

NOTE The relative humidity of the air (RH) has very little influence on the density of air at room temperature. The density of air at 20 °C and 1 013,25 hPa which is saturated with water vapour is only approximately 1 % less than equivalent dry air.

In a low-pressure system it is hardly necessary to consider the influence of static pressure on air density. In a high-pressure system, however, it can be necessary. The calculation is then performed as follows:

$$\rho = 1,293 \cdot \frac{B + 0,01 \cdot p_s}{1013,25} \cdot \frac{273,15}{273,15 + \vartheta} \tag{5}$$

## 4.4 Dynamic pressure, $p_d$

When measuring with a Pitot static tube a dynamic pressure is measured. The dynamic pressure can be used to calculate the air velocity by the use of the following formula:

$$p_d = \frac{\rho \cdot v^2}{2} \tag{6}$$