prEN 16211

- Measurement of air flows on site – methods
- Nordic guide from the 1970s by Prof Anders Svensson: ”Methods of measuring air flow in ventilation installations”
- Denmark, Norway, Sweden and Finland has a tradition of mechanical ventilation of exhaust, supply and heat exchangers.
- In Sweden, since early 1990s law of obligatory ventilation check
- 1000 of technicians using the methods – but not a EN.
- EN 12599 implies a mathematical method for pionts in duct.
- EN TC 156 - ok to develop prEN 16211, revise EN 12599:2000.

Carl Welinder, Stockholm, Suède

EN 12599 : 2012

- Ventilation of buildings – Test procedures and measuring methods for handing over installed ventilation and air conditioning systems

PrEN 16211 : UAP in 2014

- Ventilation for buildings – Measurement of air flows on site - methods

Carl Welinder, Stockholm, Suède

EN 12599, prEn 12599

87 pages: 19 pages air flow.

What to check, extent of check and measurements, What to measure, (Electric current, air flow, air temperature, filter pressure drop, ductwork leakage, humidity, sound, air velocity) and special agreed measurements, uncertainty, Test reports, How to measure?

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49 pages: Air Flow field measuring methods and their uncertainties

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Real & standard density, ch 4.5

Systematic errors, ch 5

Random errors -Measurement uncertainty, ch 6

Air flow measurement in duct, p. 13, ch 8

At Supply air terminal, p. 25, ch 9

At Exhaust air terminal, p. 26, ch 10

Example of calculation of Uncertainty

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Chapter 8:

Point measurement in duct:

Pito static pipe or hot wire anemometer

Fixed devices

Tracer gas

Air Flow in duct cross section

Air flow in duct cross section

EN 12599

- Equal area method, annular rings
- Uncertainty calculations or tables: n points - distance to disturbanc
- Circular duct: multiple of 4points
- Uncertainty: 10% 9points, $6D_h$(instrument=5%)
- Min probe dia 2,4mm, ex at 2m/s
- x 94%, ex 9mm probe, duct dia 100mm

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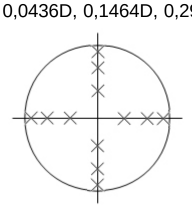
- Vel <1,4 center, no backflow
- Disturbances >5...$6D_h$ away
- Points according to table
- Circular duct: 4, 5 or 8 points
- Uncertainty: 10% (instrument=5%, method 8%, 95% confidens level)
- x 89%, dia<=160mm
- Density compensation

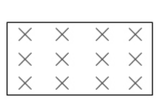
Air flow in duct cross section

EN 12599

Dsqroot(1-(2i-1)/2n)

0,0436D, 0,1464D, 0,2959D





A(2i-1)/2n

0,167A, 0,5A, 0,833A

0,125B, 0,375B, 0625B, 0875B

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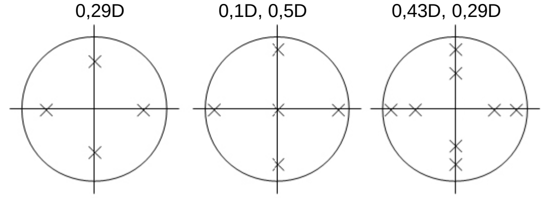
Ø100-160mm — 0,29D

Ø200-400mm — 0,1D, 0,5D

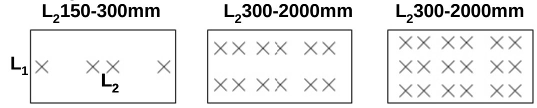
Ø500-1250mm — 0,43D, 0,29D



Height 100-400 $L_2$150-300mm

H 401-800 $L_2$300-2000mm

H 801-2000 $L_2$300-2000mm



0,08, 0,43, 0,57, 0,92 L_2

0,06, 0,235, 0,43, 0,57, 0,765, 0,94 L_2

Reference pressure

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Reference pressure $q = k (p_u)^n$

Pressure drop - Throttle device heat exchangers, plenum boxes, (PrEN12599, E.2.4.1)

Flow = k-faktor x squar root of differential pressure

In duct - fixed device/valve (ex: orfice plates)

SWEMA

Tracer gas

EN 12599

Tracer gas E.2.4.1.3

Gas meter For tracer gas? E.2.4.1.1

PrEN 16211

Tracer gas

$q = q_s/C_s$

Uncertainty 5 / 10%

SWEMA

prEn 16211

Chapter 9, 10: Measurments at terminal devices

Reference pressure

Tight bag method, only at supply

Flow hood -direct

Flow hood compensated

Pito static pipe or hot wire anemometer

Reference pressure
EN 12599, PrEN 16211

Reference pressure $q = k\,(p_u)^n$
Pressure drop - Throttle device heat exchangers, plenum boxes, (PrEN12599, E.2.4.1)

Flow = k-faktor x squar root of differential pressure

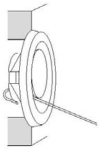
In duct - fixed device/valve (ex: orfice plates)

Exhaust air

Measuring hook

Pressure connectors (Unusual)

Supply valve (Pressure connectors)



Plenum box supply (number of straights)

Inside plenum box

Bag method

EN 12599 D.1.5.3, PrEN 16211

Bag with a calibrated volume

Fill up time -the time it takes to fill the bag

Over pressure (3 Pa) is measured in the bag

$q = V/t$ (m^3/s)

V = Volume (m^3)

t = time (s)

Funnel / Flow hood

EN 12599

Different Funnels exist. High requirements om accuracy – use compensation method

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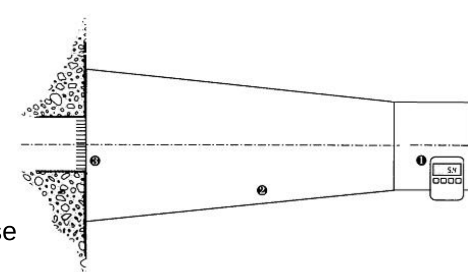
Flow hood (Funnel) uncompensated

Minimum length $\geq 3\ D_h$ supply

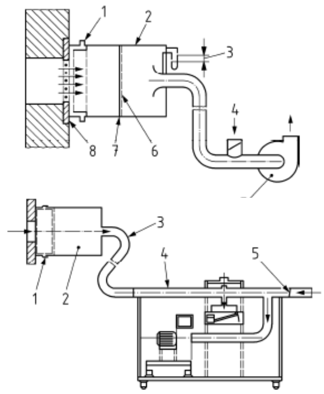


Comment: Supply valves: unstable air stream and different spread pattern. The air stream must even out

Compensation method

EN 12599

- Compensation (zero) method
  compensation method should be used for high accuracy.



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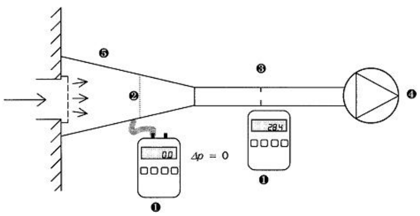
- Flow hood (Funnel)
  Compensated with auxiliary fan



Funnel / Flow hood

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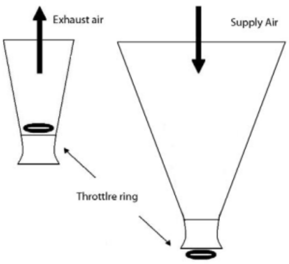
Flow hood (Funnel)

calculated from two levels of pressure drop



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Gross errors: *Human factor: stress, tiredness, lack of knowledge and understanding*

Systematic errors: *Measurements values deviates at same direction. Adjust instrument?*

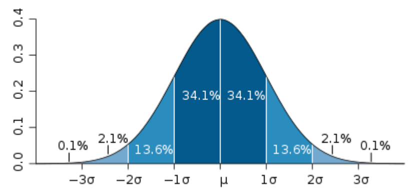
Random uncertainties: *Instrument uncertainty, method uncertainty and reading uncertainty*

Standard or Expanded Uncertainty

Standard measurement uncertainty covers 68% of all cases

Standard measurement uncertainty multiplied with 2 = expanded measurement uncertainty.

That means that with the expanded measurement uncertainty 95% of the measurements will be covered and 5% will not be.



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Measurement uncertainty

- Standard Measurement uncertainty - 68%
  $u = ((u_1)^2 + (u_2)^2 + (u_3)^2)^{1/2}$
- u_1 = standard instrument uncertainty
- u_2 = standard method uncertainty
- u_3 = standard reading uncertainty
- Expanded Measurement uncertainty, U=2u (95%)
- will cover approximately 95% of the measurements.

SWEMA

PrEN 16211 Standard Instrument uncertainty, u_1

should be stated by instrument manufacturer

Rectangular distributed:
value/(3) ^{½} is at 68% (Easy to think at 95% with 12599)

Correct by using corrections

Note: calibration uncertainty,uncertainty from the instrument itself such as hysteresis, temperature compensation, drift… can not be corrected.

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Standard method uncertainty
u_2 - 68%

Accurately specified method should be used

orientation of a probe,

distance between the probe and a grille

Influence of flow pattern

Flow pattern

SWEMA

PrEN 16211
Standard reading uncertainty
u_3 - 68%

Digital instrument - $1/(2(3)^{1/2})$ unit of last digit

SWEMA

Density compensation

PrEN 12599

- Density. Fans at 1,2 kg/m3 7.3.1.2

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When presenting a measured air flow or velocity, it should be stated if it is the real air flow or the flow converted to standard conditions that is presented.

$$v_s = v_m \cdot \rho_m / \rho_s \quad \text{m/s}$$

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Standardization

Air flow measurements on site are practised according to prEN 16211..

prEN16211 is limited to measurements of air flow rates on site, easy to use and edit.

By approving prEN 16211 as an European standard, the daily work of measurement technicians will be standardised.

SWEMA

Merci beaucoup de votre attention

Carl Welinder, Stockholm, Suède