

EUROVENT 6/10

**AIR FLOW TEST METHOD
FOR DUCTED
FAN COIL UNITS**

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1. PURPOSE

The purpose of this document is to explain the measurement method of ducted fan coil air flow-rate at speeds of choice, with an available static pressure equal to 50 Pa at medium speed. The test results describe the performance of the FC in the real condition of build installation where, as usual, the static pressure is fixed at medium speed.

2. NORMATIVE REFERENCES

- *EN 1397:2001 - Heat Exchangers - Hydronic room fan coil units - Test procedure for establishing the performances*
- *ISO 5801:1997- Industrial fans – Performance Testing using standardized airways*

3. DEFINITIONS

An **Ducted Fan Coil Unit** is a factory-made assembly which provides the functions of cooling and/or heating air using hot or chilled water with air flow to the room ensured by one or more electrically driven fans. Fan Coil Units may be of the chassis style, concealed within the building structure with ducting appropriately connected to the inlet and/or outlet of the unit.

The principal components are:

- one or more heat exchangers
- one or more fans with electric motors
- an appropriate enclosure
- condensed water collecting facilities when cooling
- air filter
- discharge plenum

Available Static Pressure: The available air static pressure at the discharge air-way cross section of the unit.

Air Flow rate: Volume air flow through the discharge air-way cross section of the unit at the air flow testing conditions.

4. SYMBOLS

P_{e4}	:	static pressure at section 4	[Pa]
T_{d4}	:	dry bulb temperature at section 4	[°C]
P_{e6}	:	static pressure at section 6	[Pa]
T_{d6}	:	dry bulb temperature at section 6	[°C]
ΔP	:	differential pressure	[Pa]
$H_{u_{rel}}$:	relative humidity	[%]
P_{amb}	:	atmospheric pressure	[Pa]
T_w	:	wet bulb temperature	[°C]
T_{air}	:	air temperature	[°C]

5. TESTING REQUIREMENTS

The air flow measurements of ducted fan coil shall be carried out in compliance with the following requirements:

- at zero heat load and $20 \pm 5^\circ\text{C}$, in isotherm and stationary conditions
- at 50 Pa of available static pressure at medium speed
- with the same setting of installation for all the speeds of choice. For units with more than 3 speeds, the manufacturers shall specify a medium, maximum and minimum speed.
- speeds of choice has to be hard wired to the motor fan.
- discharge plenum installed
- air filter installed

The electrical wiring shall assure the control and the stability of the normal supply voltage of the equipment. The fan impeller speed at maximum speed shall be measured and considered as a parameter fixing the working point and it shall not vary more than 1% in 15 minutes after at least half an hour of work at maximum speed.

6. TEST SPECIFICATIONS

6.1 Test chamber

Multiple nozzles [see Figure 1 and Figure 2] within outlet chamber should be used to test the air flow-rate of ducted fan coil or, in alternative, another method with the same accuracy in accordance with ISO 5801. The geometries of the system and of its constituent parts, shall be refer to the standards ISO 5801. The chamber shall be equipped of three series of pressure tappings: the first one seeks for the P_{e4} in order to measure the pressures of the unit, the second and the third survey the differential pressure, as required to calculate the flow-rate, and the P_{e6} which is necessary to determine the air density in the test chamber. [see 5: Layout of test set-up]

An auxiliary fan and a mechanics damper simulate the real conditions of exercise of the ventilating system and generate a depression downstream of the chamber. The auxiliary fan shall be designed to produce sufficient pressure at the desired flow-rate to overcome losses through the test set-up.

The measure of the minimal flow-rate is limited from the Reynolds number related to the throat section of nozzles ($Re_d > 1,2 \cdot 10^3$). This limitation allows to get an uncertainty in the discharge coefficient (α) of $\pm 1,2\%$. Moreover in the chamber are actually installed 10 nozzles of various dimensions (2 from 1", 2 from 2", 2 from 3", 2 from 5,5", 2 from 6") symmetrically located inside the chamber, so, the nozzles staging allows to obtain always a pressure drop measured through the system above 200 Pa, that is the 20 % of full operation range (1000 Pa), this is the measuring limit of the maximum flow rate.

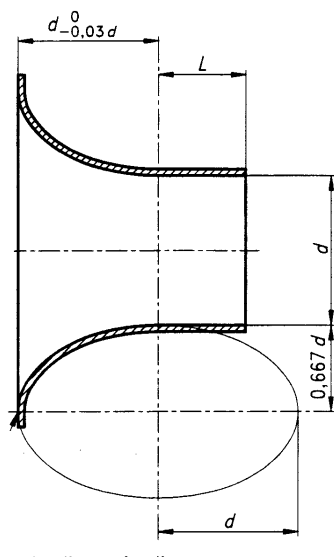


Figure 1: Nozzle geometric

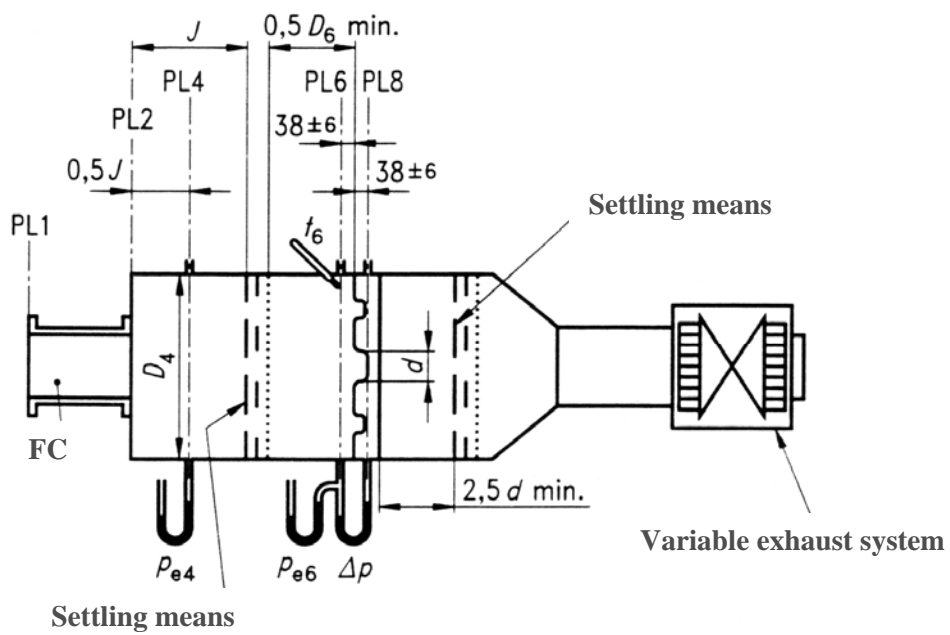


Figure 2: Flow-rate measurement chamber - multiple nozzles

6.2 Ducted fan coil set-up

Ducted fan coil units should be located in the normal operating position on the suction of the test chamber and the operating conditions shall be set by a duct and a damper. The duct shall contain all the spigots of the discharge plenum of the unit as described in the following figure.

In detail, the duct of an only frontal spigot unit shall be designed as represented in figure n°3 following the characteristics reported below:

- the minimum distance between the outlet spigot and the pressure tap must be above $0,5 \times$ hydraulic diameter.
- the maximum discharge plenum height shall be lower than $1,25 \times$ the unit height.

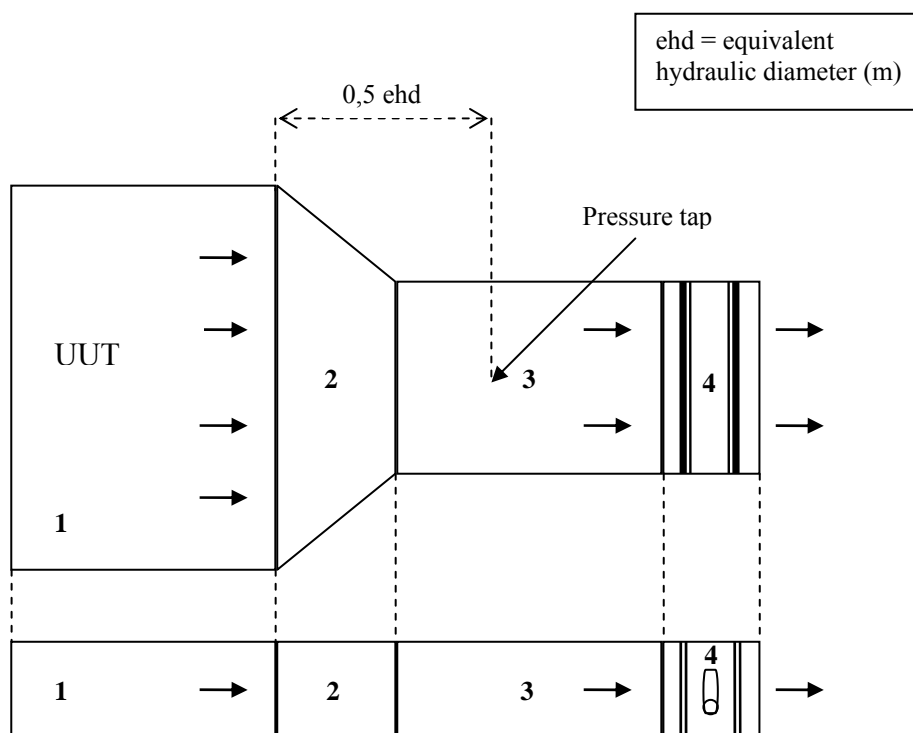


Figure 3 : Scheme of installation with duct and damper for frontal spigot units

The duct of a lateral spigot unit shall be designed as represented the figure n°4 or in figure n°5, following the characteristics:

- the minimum distance between the lateral outlet spigot and the side plenum wall shall be $0,5 \times$ hydraulic diameter
- the maximum discharge plenum height shall be lower than $1,25 \times$ the unit height
- the angle of the restriction between the discharge plenum and the damper must lower than 15°
- the discharge plenum length must be longer than two hydraulic diameters (of the rectangular plenum section) defined in the ISO 5801 standard

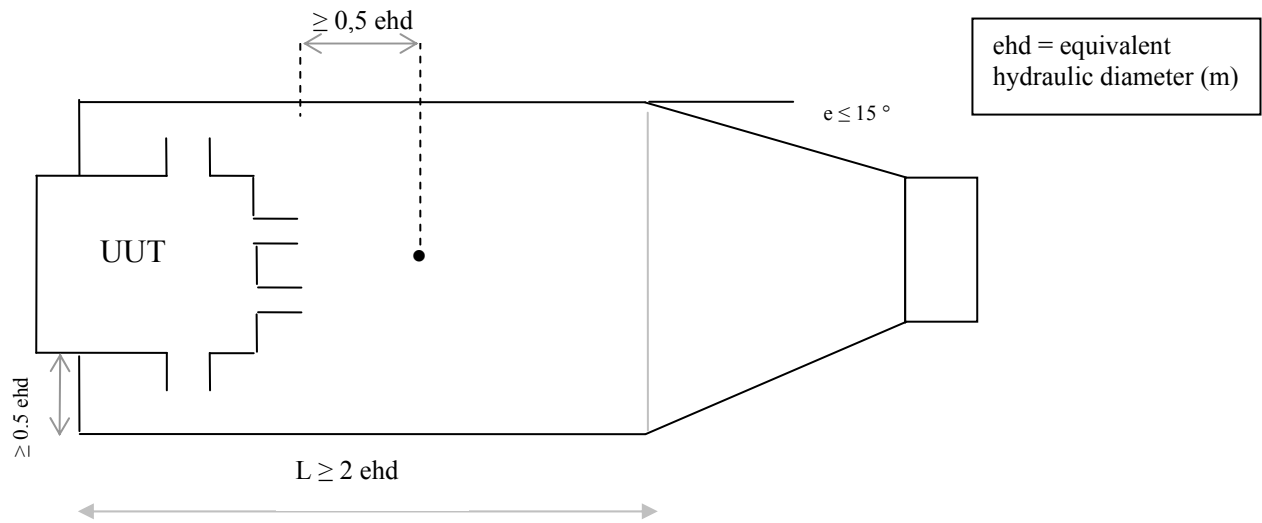


Figure 4 : Scheme of installation with duct and damper for lateral spigot units.

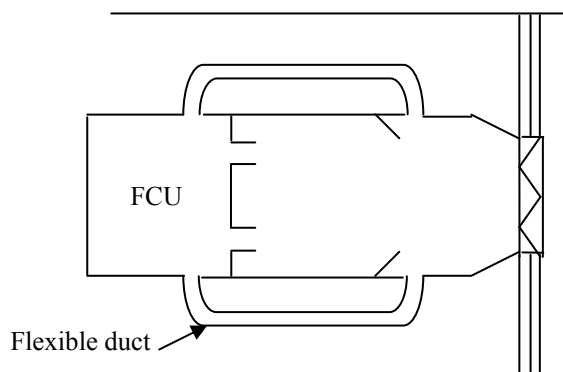


Figure 5 : Scheme of installation with duct and regulating damper an flexible pipes for lateral spigot units.

N.B. to avoid set-up problems, the flexible pipes installation could be used for big units only.

There should not be any additional resistance on the UUT air suction except the normal operating filters included by the manufacturer.

7. TEST PROCEDURE

The Air flow rate shall be measured in accordance with ISO 5801 (multiple nozzles or Venturi nozzle). The procedure is the following:

- 1) the unit shall be installed in accordance ISO 5801 and set at medium speed (for multi speed units, the medium speed is defined by the manufacturer)
- 2) the UUT damper shall be set to measure 50 Pa at the discharge air-way cross section of the unit, while the auxiliary fan and damper of the test chamber allow to have a static pressure of 0 Pa at the inlet (Pe4) as described in the figure 6. In these conditions all the data necessary to detecting air flow-rate shall be stored

- 3) the FC speeds shall be selected without changing the UUT damper settings.
- 4) the test chamber auxiliary fan and damper shall be set to have a static pressure of 0 Pa at the inlet for each speed. In these operating conditions, all the data necessary to detecting air flow-rate shall be stored
- 5) after a few minutes (necessary to have flow-stability) the new data will be stored
- 6) the procedure will be repeated in points 4), 5) and 6) to store the data the other speeds of the ducted fan coil.

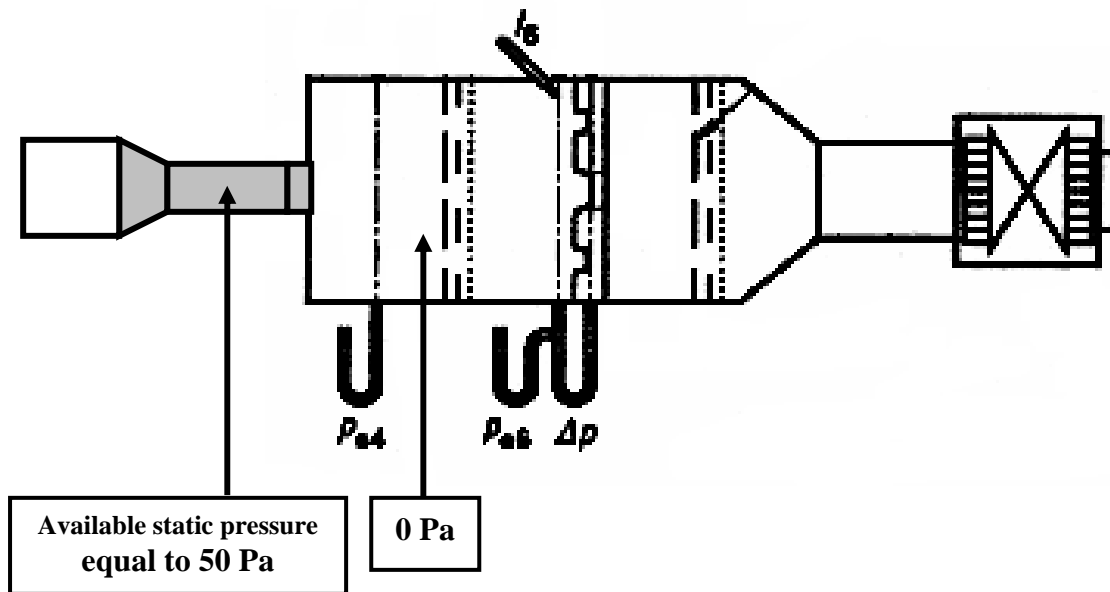


Figure 6. Scheme of installation of the unit on the test chamber (operating conditions at medium speed)

8. TEST RESULTS

The following measurements shall be taken during the test:

- Supply voltage
- Current
- Power input
- Rotational speed
- Available static pressure at the discharge air-way cross section of the unit
- Differential static pressure through the nozzles, Δp
- Upstream pressure, P_{e6}
- Upstream temperature, t_6
- Chamber pressure, P_{e4}
- Chamber temperature, t_4
- Atmospheric pressure at the mean altitude of the fan coil, p_a
- Ambient dry-bulb temperature near the inlet of the UUT, t_a
- Ambient relative humidity, near the inlet of the UUT, HU_{rel}

9. UNCERTAINTIES MEASUREMENTS

The uncertainties of measurement shall not exceed the values specified in the ISO 5801 standard.