

EUROVENT 8/12

**SOUND TEST METHOD
FOR DUCTED
FAN COIL UNITS**

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1 - PURPOSE

The purpose of this document is to describe the measurement method of Ducted Fan Coil Units sound power level, at speeds of choice with an available static pressure equal to 50 Pa at medium speed. The sound power levels are calculated in frequency bands from sound pressure level measurements in a double reverberation room. 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

- *ISO 3741:1999 Acoustics -- Determination of sound power levels of noise sources using sound pressure - Precision methods for reverberation rooms*
- *EN 1397:2001 Heat Exchangers – Hydronic room fan coil units – Test procedure for establishing the performances*

3 - DEFINITIONS

3.1 - Ducted Fan Coil Unit

the ducted FC 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

3.2 - Sound Pressure: p

Fluctuating pressure added to the static pressure by the presence of a sound.

3.3 - Sound Power: w

Total sound energy radiated by the UUT per time unit.

3.4 - Sound Pressure level L_p

$$L_p = 20 \log_{10} (P/P_0) \quad (\text{dB}) \quad (1)$$

where:

P is the mean square sound pressure (Pa)
 P_0 is the reference sound pressure ($2 \cdot 10^{-5}$ Pa)

3.5 - Sound Power level L_w

$$L_w = 10 \log_{10} (W/W_0) \quad (\text{dB}) \quad (2)$$

where:

W is the sound power (W)
 W_0 is the reference sound power (1 picowatt)

3.6 - Frequency range of interest

The frequency range of interest includes the one-third octave bands with centre frequencies between 100 and 10000 Hz.

100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000
5000 6300 8000 10000

3.7 - Reverberant sound field

The portion of the sound field in the test room over which the influence of sound received directly from the source is negligible.

4 - TEST METHOD

It is generally recognized that the sound spectrum of fan coil units contains sometimes discrete frequency components. The testing method allows therefore the determination of the sound power of sources emitting discrete frequency sounds, in compliance with ISO 3741 requirements.

5 - TEST SET-UP

5.1 - Reverberation room

Sound measurements of ducted Fan Coil Units are performed in a double reverberation room, which shall be qualified for the measurement of broad-band noise according to the Standard ISO 3741 (appendix E). Since the sound spectrum of fan coil units usually contains discrete frequency components it would be useful to qualify the room for the measurement of this type of noise always in agreement with the Standard ISO 3741 (appendix A).

5.2 - Equipment location

In the inlet, radiated and outlet sound power level measurements of ducted FC, the unit shall be installed as similar as possible like shown on Figure 1.

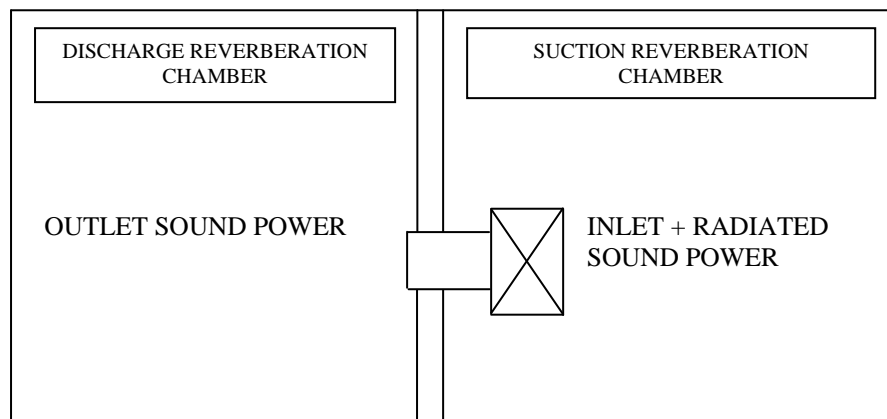


Figure 1 : Scheme of installation of ducted FC in the reverberation rooms

N.B. the insulation partition between the reverberation rooms is built by high density material (> 50 kg/m³) and shall have a depth of at least 200 mm.

The outlet ducts (for lateral and frontal spigot units) shall have the following characteristics:

- they shall contain all the spigots of the discharge plenum of the unit.

- the minimum distance between the lateral outlet spigot and the side plenum wall shall be 0,5 x hydraulic diameter
- the maximum discharge plenum height shall be lower than 1,25 x 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
- they shall be acoustically insulated
- No flexible pipes shall be used in the acoustical measurements set-up

N.B. see 6.2 paragraph of Eurovent 6/10 document figures

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

5.3 - Operating conditions

Acoustical measurements of Ducted Fan Coil Unit shall be carried out in compliance with the following requirements:

- at $20 \pm 5^{\circ}\text{C}$, in isotherm and stationary conditions
- at zero heat load
- at the operating conditions measured in the air flow-rate test
- the 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.

In order not to introduce external noise, during the acoustic tests, the working conditions recorded during the air-flow rate test (available static pressure and rotational speed) shall be performed by using the reconditioning blowers of the reverberation rooms.

6 - TEST PROCEDURE

6.1 - Measurement of sound pressure level

The sound pressure level spectrum of the unit in one-third frequency bands shall be measured in sequence for each speed of choice. Between the measurements it is important to wait some time to have more stability in the operating conditions written above. If the sound pressure level spectrum contains some discrete frequency components in one or more bands, this shall be recorded and written in the test report.

6.2 - Measurement of background noise and reference sound source

The background noise in one-third frequency bands shall be measured for each speed of choice without the equipment running while the reconditioning system is set as for the sound pressure level acquisition of the unit for each speed of choice.

Between the measurements it is important to wait some time to have more stability in the operating conditions written above. This background noise shall be at least 6dB below the sound pressure level measured in each frequency band of the frequency range of interest. The corrections for background noise shall be calculated according to the ISO Standard 3741 Paragraph 8.1.4.

If the comparison method is used, the reference sound source sound pressure level with the reconditioning system set used for the maximum speed of choice for each chamber shall be measured.

6.3 - Additional quantities to be measured

In addition to the quantities defined in the acoustical standard required for the calculation of emitted sound power, all the parameters that allow the determination of the operating point of the fan coil unit on test shall be measured.

In particular shall be measured the following parameters:

- Rotational speed
- Supply voltage
- Current
- Power input
- Dry and Wet bulb temperatures of each room
- Barometric pressure
- Differential pressure in the inlet chamber
- Available static pressure at the discharge air-way cross section of the unit

6.4 - Calculation of sound power level

The sound power level of the unit shall be calculated in each one-third octave frequency band from the sound pressure level measured in the reverberation room as described in the comparison method of ISO 3741, where the measured sound pressure levels are compared with the sound pressure levels produced in the same room by a reference sound source of known sound power output.

In the comparison method, all of the measured one-third octave band sound pressure level data shall be converted to one-third octave band sound power levels using the following formula.

$$L_{w(n)} = L_{p(n)} + [L_{wr(n)} - L_{pr(n)}] \quad (3)$$

where:

$L_{w(n)}$ is the test unit sound power level, dB, in the n^{th} one-third octave band

$L_{p(n)}$ is the test unit measured sound pressure level, dB, in the n^{th} one-third octave band

$L_{wr(n)}$ is the RSS sound power level, dB, in the n^{th} one-third octave band

$L_{pr(n)}$ is the RSS measured sound pressure level, dB, in the n^{th} one-third octave band

7 - UNCERTAINTIES OF MEASUREMENTS

The uncertainties of measurement shall not exceed the values specified in the ISO 3741 standard.

8 - PRESENTATION OF THE RESULTS

The test report shall include:

- Sound power levels per one-third octave band for all the operating points of the ducted Fan Coil Unit. In detail, the following characteristics shall be reported:
 - inlet + casing radiated sound power level spectrum
 - outlet sound power level spectrum
- A weighted sound power level expressed in dB (A) calculated from the spectrum according to ISO 3741 Annex F for all sound powers measured.