BS EN 16583:2015

BSI Standards Publication

Heat exchangers — Hydronic room fan coils units — Determination of the sound power level

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee RHE/17, Testing of air conditioning units.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Heat exchangers - Hydronic room fan coils units - Determination of the sound power level

Échangeurs thermiques - Ventilo-convecteurs à eau - Détermination du niveau de puissance acoustique

Wärmeübertrager - Wasser-Luft-Ventilatorkonvektoren - Bestimmung des Schallleistungspegels

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

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European foreword

This document (EN 16583:2015) has been prepared by Technical Committee CEN/TC 113 “Heat pumps and air conditioning units”, the secretariat of which is held by AENOR.

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of an identical text or by endorsement, at the latest by February 2016, and conflicting national standards shall be withdrawn at the latest by February 2016.

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1 Scope

This European Standard applies to hydronic fan coil units (FCU) as factory-made single assemblies which provide the functions of cooling and/or heating but do not include the source of cooling or heating.

The standard covers both air free delivery and air ducted units with a maximum external static pressure due to duct resistance of 120 Pa max.

This European Standard provides methods for the determination of the acoustical performance of fan coil units, defining standard working condition and installation.

It is not the purpose of this standard to specify the tests used for production or field testing.

NOTE For the purpose of remaining clauses, the term “unit” is used to mean “fan coil unit” as defined in 3.1 of EN 1397:2015.

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 1397:2015, *Heat exchangers - Hydronic room fan coil units - Test procedures for establishing the performance*

EN ISO 3741, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms (ISO 3741)*

EN ISO 3743-1, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for small movable sources in reverberant fields - Part 1: Comparison method for a hard-walled test room (ISO 3743-1)*

EN ISO 3743-2, *Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering methods for small, movable sources in reverberant fields - Part 2: Methods for special reverberation test rooms (ISO 3743-2)*

EN ISO 3744, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane (ISO 3744)*

EN ISO 3745, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for anechoic rooms and hemi-anechoic rooms (ISO 3745)*

EN ISO 9614-1, *Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 1: Measurement at discrete points (ISO 9614-1)*

EN ISO 9614-2, *Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning (ISO 9614-2)*

EN ISO 9614-3, *Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 3: Precision method for measurement by scanning (ISO 9614-3)*

EN ISO 80000-8:2007, *Quantities and units - Part 8: Acoustics (ISO 80000-8:2007, corrected 2007-08-15)*

3 Terms and definitions

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

3.1
hydronic fan-coil unit
factory-made single assembly which provides one or more of the functions of forced circulation of air, heating, cooling, dehumidification and filtering of air, but which does not include the source of heating or cooling

Note 1 to entry: This device includes at least a liquid-to-air heat exchanger and a fan, and may be designed for free or ducted intake air and/or for free or ducted delivery of supply air.

3.2
total electric power input
total electric power absorbed by the unit, including fan(s) and auxiliary devices but excluding any electrical resistance heater

3.3
standard fan speed
fan speed setting declared by the manufacturer and used for setting the air flow rate conditions of ducted units

Note 1 to entry: The fan speed setting can be declared by the manufacturer as a certain wiring, a switch position or a steering voltage.

3.4
external static pressure
positive pressure difference measured between the air outlet and inlet sections of the unit

3.5
acoustics
for acoustic quantities, the definitions of EN ISO 80000-8:2007 apply

4 Measuring instruments

The acoustic instruments shall fulfil the requirements of the acoustic standard used for the test.

Other measurements can be necessary for the tests:

— Electrical: voltage (V), current (A), total electric power input (W);

— Pressure (Pa);

— Rotation speed (min^{-1}).

Measurements for the ambient conditions:

— Relative humidity (%);

— Air Temperature (°C);

— Atmospheric pressure (kPa).

Table 1 gives the uncertainties allowed for these measurement values.

Table 1 — Uncertainties of measurement for indicated values

Measured quantity	Unit	Uncertainty of measurement
Air — static pressure difference	Pa	± 3 Pa (ΔP ≤ 100 Pa) ± 3% (ΔP > 100 Pa)
Electrical quantities — Voltage — Current — Power	 V A W	 ± 0,5 % ± 0,5 % ± 1 % or minimum 1 W
Rotation speed	min^{-1}	± 1 %
Relative humidity Atmospheric pressure Temperature	HR kPa °C	5 % 1 % ± 0,5 K

5 Operation of the unit

The testing conditions are given in EN 1397:2015 except the following:

— The acoustic test shall be performed without connection to water supply, without water staying in the water circuit, with dry coil surface and an inlet air temperatures between 15 °C and 25 °C.

— The control of the relative humidity is not required.

If the unit includes flaps, they shall be adjusted in a fixed position according to the manufacturer instructions. If this information is not available, their position shall correspond to the maximum mechanical open position.

NOTE 1 This maximum mechanical open position might differ from the minimum airflow resistance.

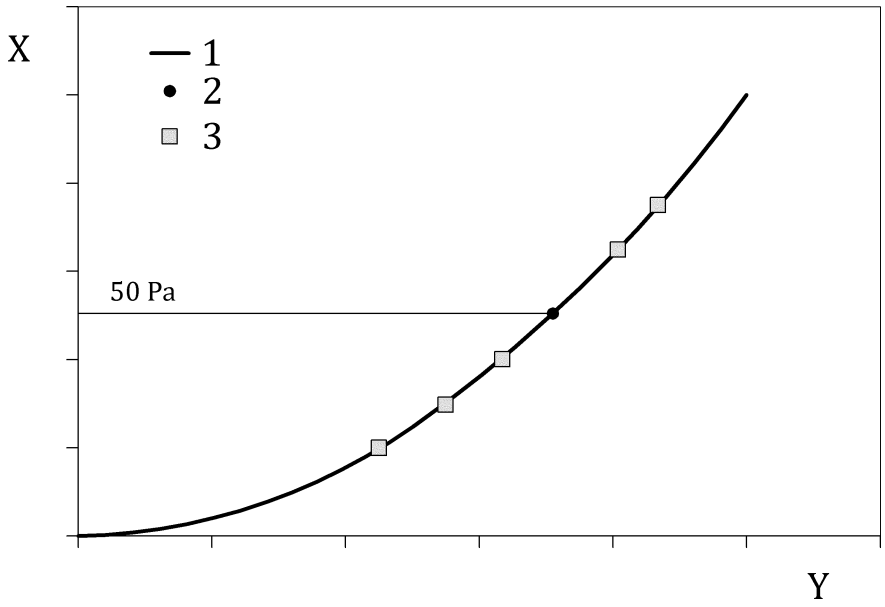
For testing, the unit shall include an air filter but no any other accessory for air inlet or diffusion or others. Dampers for fresh air intake shall be closed.

NOTE 2 No modification such as sealing is made on the unit before testing.

For ducted units, an external static pressure difference of 50 Pa (± 1 Pa) shall be applied to the unit for the standard fan speed declared by the manufacturer.

If other speeds are tested, the same network curve resistance shall be used. See Figure 1.

If the resistance is obtained by using an auxiliary fan, preliminary tests shall be done to determine the external static difference for each additional speed.



Key

1 ductwork load curve
2 reference standard speed
3 other speeds
X external static pressure difference
Y flow rate

Figure 1 — Setup external static pressure difference of ducted units for other speeds

6 Installation

6.1 General

The typical types of units are presented in the annex of EN 1397:2015.

Tests shall be made in suitable acoustic test chambers.

6.2 Non ducted units

6.2.1 General

The target is the sound power level radiated by the whole unit, without distinction of inlet or discharge sides nor casing radiation.

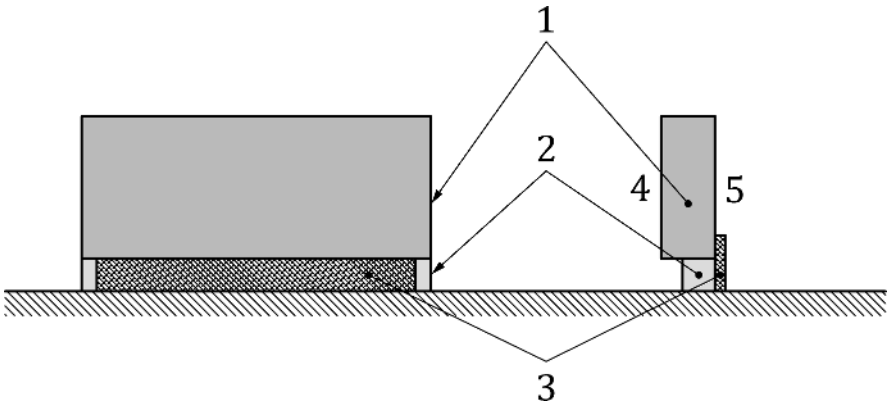
6.2.2 Floor mounted unit

The unit shall be installed on the hard floor at a minimum of 1 500 mm away from any wall out of any symmetry axis.

The feet provided by the manufacturer shall be used.

For aerodynamic purpose, the space between the feet shall be closed in the rear part to simulate the wall, with a rigid and reflective plate, with the same width of the unit and not exceeding its height. See Figure 2.

This plate shall be in chipboard or equivalent, density 600 kg/m³ to 700 kg/m³, and thickness 19 mm to 22 mm.



Key

1 fan coil unit
2 feet
3 plate to close the space between the feet on the rear side
4 front side of the fan coil unit
5 rear side of the fan coil unit

Figure 2 — Floor mounted unit with a closing plate between the feet

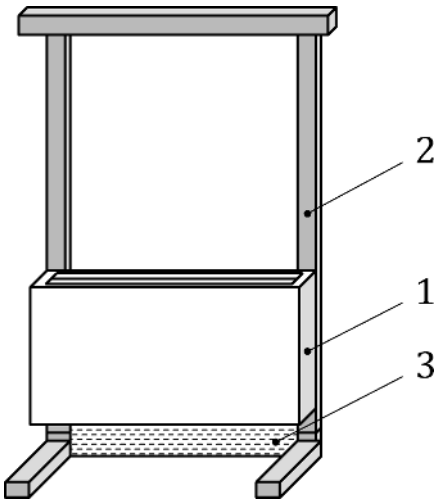
6.2.3 Wall mounted unit

For low-wall mounting units, the distance to the floor given by the manufacturer shall be respected. Without information from the manufacturer, this distance shall be 150 mm.

For aerodynamic purpose, the space between the unit and the floor shall be closed in the rear part to simulate the wall, with a rigid and reflective plane, with the same width of the unit and not exceeding its height. See Figure 3.

The characteristics of the frame shall be such that any impact on the acoustic measurement by the frame radiation may be avoided.

This plate shall be in chipboard or equivalent, density 600 kg/m³ to 700 kg/m³, and thickness 19 mm to 22 mm.



Key

1 fan coil unit

2 supporting frame

3 plate to close the space between the unit and the floor, at the rear side

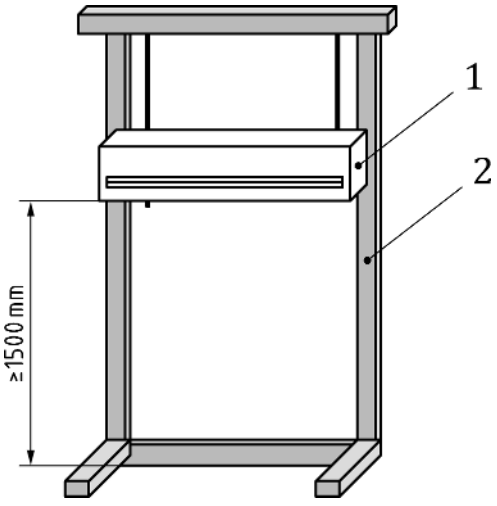
Figure 3 — Example of installation low wall unit mounted on a frame, with the back plate

6.2.4 High wall mounted unit

The unit shall be installed on a frame at a minimum of 1 500 mm away from any wall, out of any symmetry axis.

For high-wall units, the height shall be at a minimum of 1 500 mm from the floor. See Figure 4.

The characteristics of the frame shall be such that any impact on the acoustic measurement by the frame radiation may be avoided.



Key

1 fan coil unit

2 supporting frame

Figure 4 — Example of installation of high wall unit mounted on a frame

6.2.5 Cassette and under ceiling mounted units

The unit shall be hung on a frame, using elastic connection (elastic strap or uncoupled rigid stinger) to avoid vibration transmission, linked to the unit according to the manufacturer instructions.

No additional plate is allowed on the top of unit to simulate the ceiling.

The distance between the bottom of the unit and the floor shall be at a minimum of 1 500 mm, see Figure 5.

The distance between the top of the unit and the ceiling of the testing room shall be at least 1 500 mm.

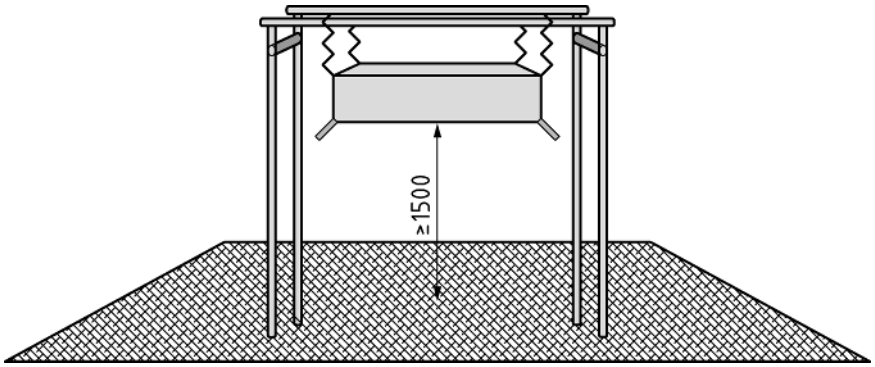


Figure 5 — Example of installation of cassette unit mounted on a frame

6.2.6 Under floor mounted

The unit shall be installed directly on the floor at a minimum of 1 500 mm away from any wall, out of any symmetry axis (see Figure 6). A soft and thin layer (maximum 5 mm thick and 20 mm width) can be inserted on the perimeter to ensure a good contact between the unit and the floor, avoiding sheet vibrations.

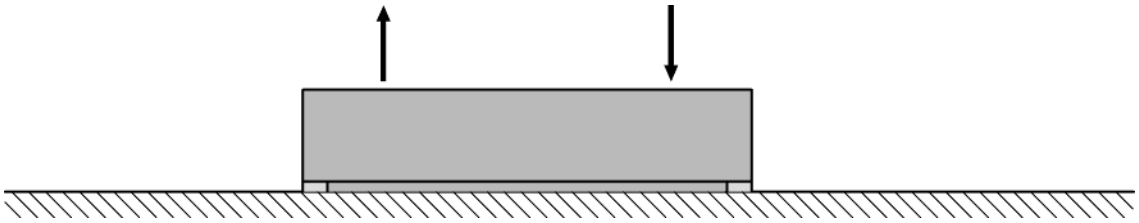


Figure 6 — Example of unit under floor mounted

6.3 Ducted units

6.3.1 General

In the case of free inlet / ducted discharge configuration, two sound power levels can be determined:

— discharge;

— inlet + radiated by the casing (the radiated sound level is generally negligible compared to the inlet one).

In case of ducted inlet / ducted discharge unit, three sound power levels can be determined:

— discharge;

— inlet;

— radiated by the casing.

The ducted units are usually designed to be suspended and shall be hung for the acoustic test, according to the manufacturer instructions.

If a damper is installed on the suction side instead of discharge side, the pressure loss could differ due to the leakage (e.g. the drain) of the unit. Therefore, the rotation speed shall be adjusted to the one measured at the discharge configuration.

When a damper is required to adjust the pressure, the generated sound level due to airflow shall not influence the unit sound power level determination. It is then recommended to install it on the opposite side of the measuring duct.

6.3.2 Discharge or inlet sides

6.3.2.1 General

Whatever the configuration of the discharge side (resp. inlet) of the unit, rectangular opening or with one or several spigots, only one sound power level has to be declared for the discharge (resp. inlet), corresponding to the sound power level of the unit, injected into the duct(s) by the unit.

NOTE It is not mandatory to declare a sound power level for each spigot. If the N spigots are of same diameter, it can be assessed by Lw (i^{th} spigot) = Lw (N spigots) – 10 lg (N).

As the sound level is conveyed by one or several ducts, the sudden acoustic impedance change at the free end of the duct creates a reflection of the sound in the duct, the sound transferred to the measurement space being reduced. The duct end correction (see 6.3.2.5) shall then be applied to take into account this reflection effect, giving the sound power level travelling in the duct.

The ducted side to be measured is connected to a straight duct without bend, with a length comprised between 1 000 mm and 2 000 mm, preferably 1 500 mm.

The dimensions of the inlet section of the rectangular duct connected to the unit shall be at least of the same external dimensions as the unit, with a total tolerance of [0 mm : + 40 mm] on the width as well as on the height. The air tightness between the duct and the casing of a unit shall be ensured by soft joints.

The duct shall be uncoupled from the unit to avoid vibrations transmission and disturbing noise radiation.

The section of the duct at its inlet and at its outlet shall not differ of more than 20 %, with a constant change rate.

No internal lining with absorbing material is allowed into the duct between the unit and the measurement area, so that there is no significant acoustic loss throughout the duct. For this reason, the duct breakout shall be high enough to avoid high transmission of the noise through the duct walls. The specific mass of rectangular ducts is recommended to be at least 10 kg/m².

Whatever the acoustic field in which tests are performed, the minimum distance of 1 500 mm for the duct termination shall apply whenever the walls conforming the nearest corners to the duct end are forming an angle close to 90º (see Figure 7). Irregular perimeter walls (e.g. angle between the walls more than 120°, see Figure 8) could be closer with negligible influence over the sound power radiated by the duct end.

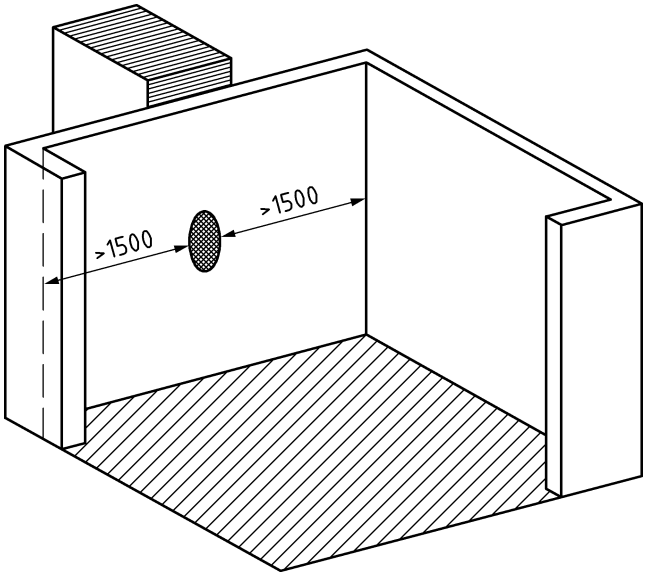


Figure 7 — Duct termination flush to the wall

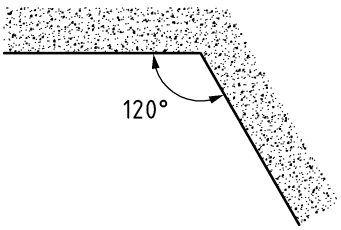


Figure 8 — Open angle of 120°

6.3.2.2 I-Y-H Type ducted units

See Figures 9 to 11.

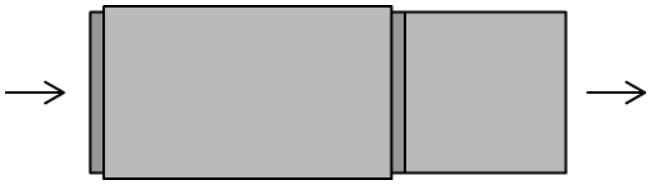


Figure 9 — I type ducted unit

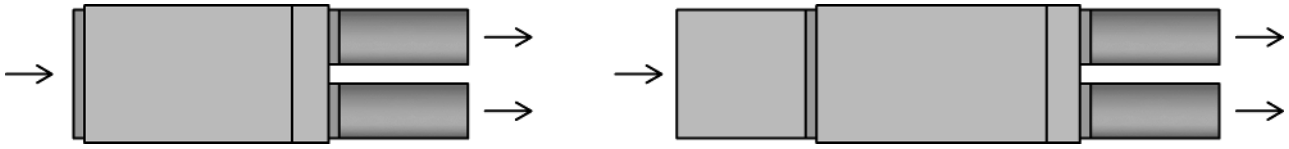


Figure 10 — H type ducted units

Figure 11 — H type ducted unit

For units with spigots, two duct configurations are allowed:

— a rectangular duct, including all spigots,

— a duct on each spigot, of same shape and section (usually, circular).

The following figures present the usual installation configurations. See Figures12, 13 and 14.

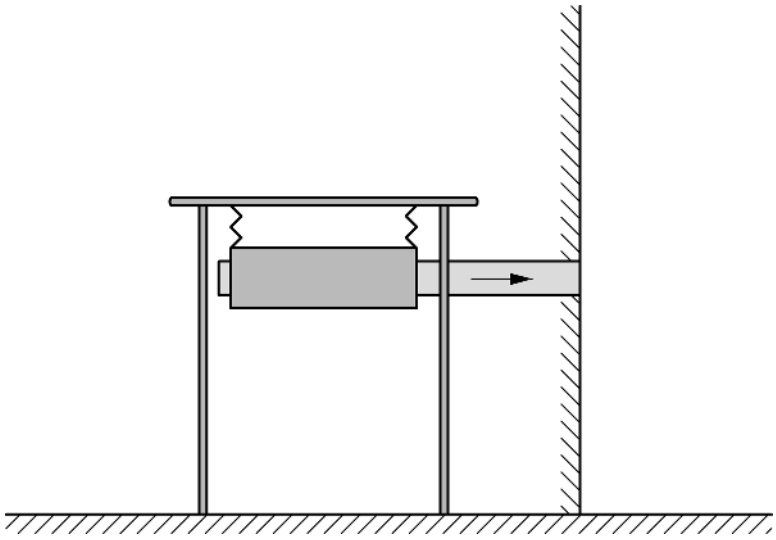


Figure 12 — Typical installation for the measurement of discharge sound level on the right side and free inlet + sound radiated by the casing on the left side

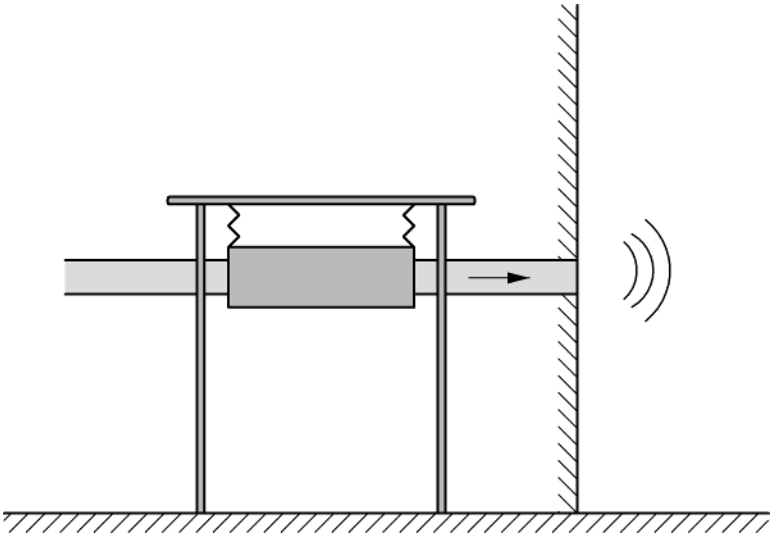


Figure 13 — Typical installation for the measurement of discharge sound level with ducted inlet

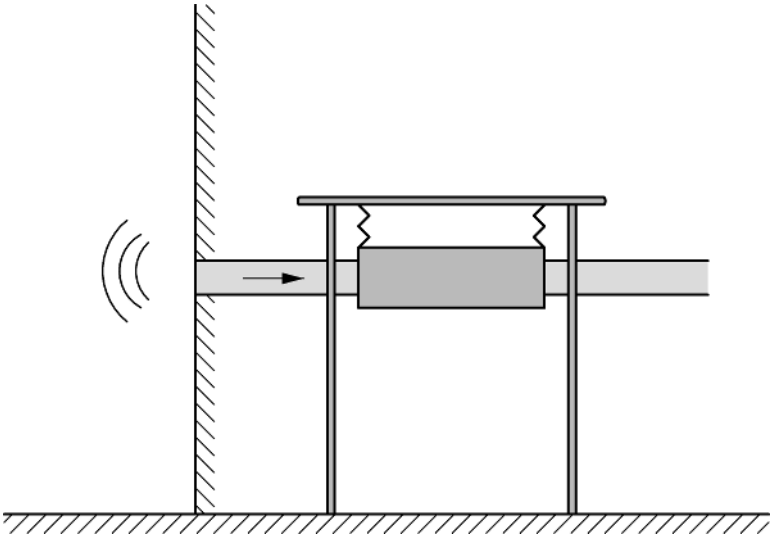


Figure 14 — Typical installation for the measurement of inlet sound level with ducted discharge

6.3.2.3 U-type units

See Figure 15.

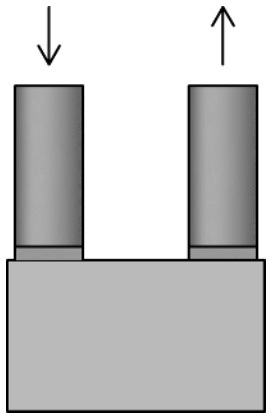
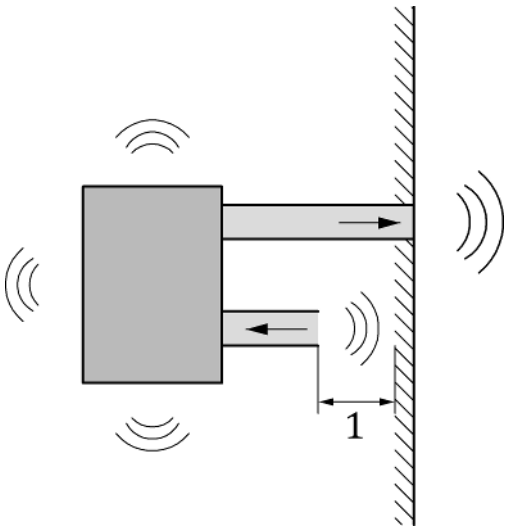


Figure 15 — U-type fan coil unit

Some units present spigots on the same side (U type), usually one inlet circular duct and one discharge circular duct.

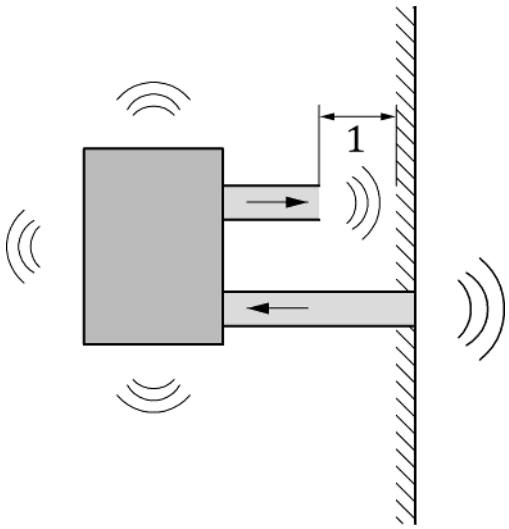
The duct on the measured side shall fulfil the requirements of 6.3.2 whereas the other duct need to be shorter but minimum 1 000 mm, while ensuring a correct air movement and avoiding the vicinity of a wall which could disturb the inlet flow A minimum distance shall be equal to 500 mm or 3-times the duct diameter between the wall and the shortest duct (see Figures 16 and 17).



Key

1 3-times the duct diameter but not less than 500 mm

Figure 16 — Installation for the measurement of discharge sound level for U-type unit (and inlet + radiated)



Key

1 3-times the duct diameter but not less than 500 mm

Figure 17 — Installation for the measurement of inlet sound level for U-type unit (and discharge + radiated)

6.3.2.4 Units with lateral spigots

In the case of unit with lateral discharge spigots, the measurement for the discharge side is done in the room in which the casing is installed, as it is assumed that the noise radiated by the casing is negligible compared to the discharge sound level. The inlet side is connected to the other room to ensure the pressure difference between the two spaces.

Whatever the case of free inlet or ducted inlet, the Figure 18 applies for this kind of unit.

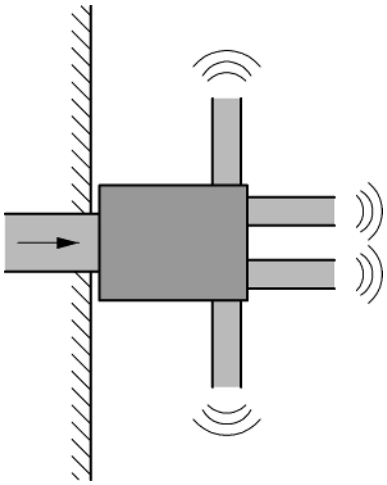


Figure 18 — Installation for measurement of inlet sound level of units with lateral spigots (upper view)

6.3.2.5 Duct end correction

The duct end termination E takes into account the acoustic impedance change at the end of the duct(s).

$$E = 10 \lg \left[1 + \left(\frac{c}{4\pi f} \right)^2 \frac{\Omega}{S} \right] \quad (1)$$

Where

c is the celerity of sound, expressed in meter per second (m/s);

f central frequency band, expressed in hertz (Hz);

S is the section of duct opening in the measurement space, expressed in square meter (m²);

Ω is the solid angle of the radiation field:

— 2π for flush termination,

— 4π for free termination (as it is the case for units with lateral spigots). Free termination is determined if the duct ends at more than ½ wavelength of the lowest considered frequency of the wall.

Finally

Lw in the duct = Lw measured outside + E (2)

If the duct has not a constant section, the correction shall be applied to the discharge section where the duct ends in the room (measurement side).

NOTE Although the initial theory corresponds to circular ducts, the duct correction can be applied to rectangular ducts section as well.

If measurements are done together on several spigots with same diameters, the duct end correction shall only be applied one time, the section S term corresponding to the section of one duct.

If a unit with several spigots is ducted by a rectangular duct, the correction corresponds to the end section of the rectangular duct.

6.3.3 Sound level radiated by the casing

The measurement of the sound level radiated by the casing requires the use of ducts with a high sound insulation.

Double layer ducts should be used to reduce the sound level radiated by the duct walls. They are constituted by an external hard wall duct, a layer of soft material to ensure the vibration uncoupling between external and internal duct (usually glasswool or rockwool), and a hard wall internal duct.

The internal duct might be perforated to act as a silencer and decrease the sound level all along the path. In that case, these kind of ducts are not suitable for the simultaneous inlet/discharged sound level measurement.

The experimenter shall check that the duct radiation and the sound emitted by the openings of the ducts do not disturb the casing radiation measurement.

The sound spectrum of fan coil units usually presents higher level in the low-medium frequency range than in high frequency range. The use of circular ducts is then recommended as they naturally present a higher sound insulation in the low and medium frequency ranges.

Methods based on free field such as intensity-based or pressure-based measurement are usually convenient for this characterisation. In that case, it is helpful to add screens in order to reduce the influence of noise radiated at the end of the ducts.

For acoustic measurements based on diffuse field, the use of duct with high sound insulation is crucial and double layer ducts shall be used.

Usually, double layer circular ducts are easier to build than rectangular ones, and lead to higher sound insulation. To reduce the sound radiation of the duct, it is also possible to decrease the sound energy travelling into the duct by installing silencer on each side of the unit. The experimenter should take care of the own silencer radiation.

In the case of unit with lateral spigots, the radiated sound measurement shall be performed on the corresponding in-line casing (I-type or H-type or Y-type).

To characterise the noise radiated by the casing of U-type units, they shall be installed according to the Figure 19. Ducts with high insulation shall be used. The unit shall be at least at 1 000 mm from the wall.

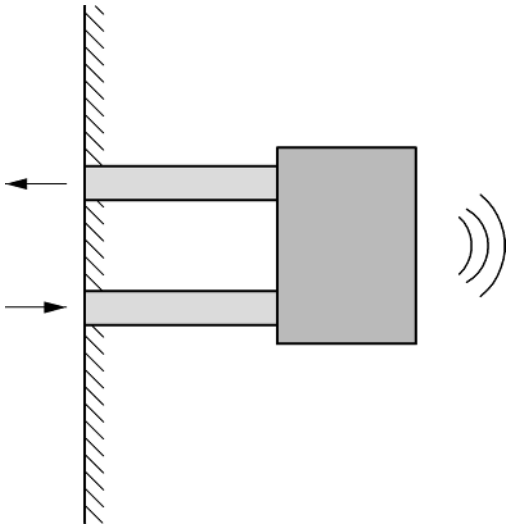


Figure 19 — Installation of a U-type: noise radiated by the casing

7 Acoustic measurement

7.1 Frequency range

The frequency range of interest is (100 – 10 000) Hz for one-third octave bands and (125 – 8 000) Hz for octave bands analysis.

NOTE For intensity method using a pair of microphones, the EN ISO 9614 (all parts) methods limit the highest frequency to 6 300 Hz. But, with rare exceptions, the 8 000 Hz and 10 000 Hz frequency bands usually do not have an impact on the overall dB(A) sound power level. The octave bands spectrum then covers the 125 Hz to 4 000 Hz range.

7.2 Acoustic standard

Any kind of the engineering or precision method standards shall be used: EN ISO 3741, EN ISO 3743-1, EN ISO 3743-2, EN ISO 3744, EN ISO 3745, EN ISO 9614-1, EN ISO 9614-2 and EN ISO 9614-3.

7.3 Diffuse field

The use of diffuse field method is convenient to measure the sound level at inlet or discharge sides, such as EN ISO 3741 or EN ISO 3743-1 and EN ISO 3743-2.

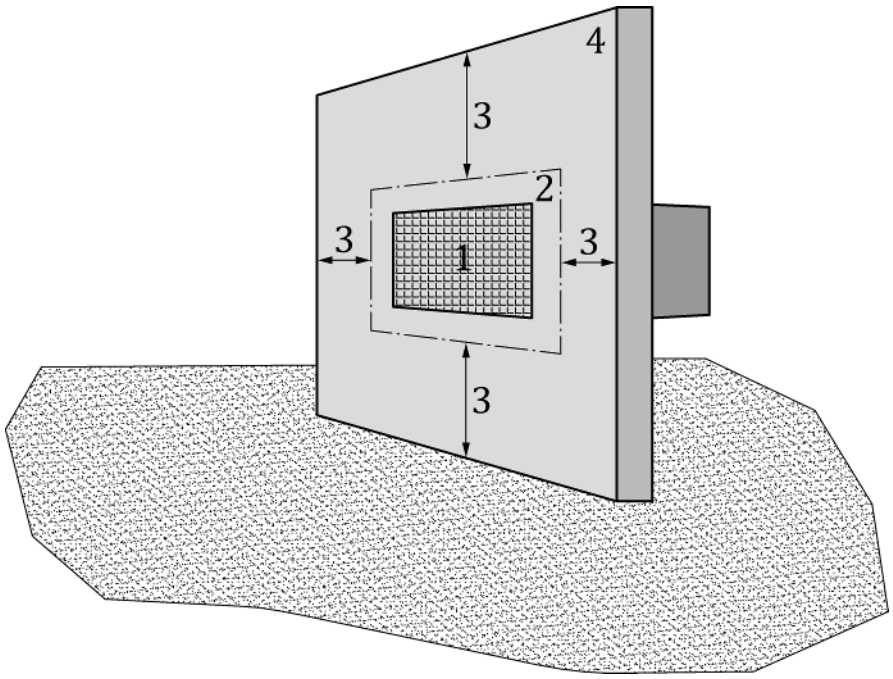
Furthermore, the use of rooms allows to manage the pressure between the sides of the fan coil unit.

The main disadvantage of this method is the radiation of the ducts, for the measurement of the noise radiated by the casing.

7.4 Free field

The methods based on free field environment such as EN ISO 3745, EN ISO 3744 (or intensity method EN ISO 9614 (all parts)) is very convenient for the noise radiated by the casing. It can also be used for the **discharge or inlet noise** (Figures 13, 14, 17, 18), but the screen to be used to simulate the wall shall be large and massive enough to ensure a sufficient reflecting plane (Figure 20).

This plane shall be reflective with an absorption coefficient maximum α = 0,06. Its size shall be bigger than the measurement surface projection of minimum 500 mm on each side.



Key

1	end section of the duct	3	minimum distance (500 mm)
2	projection of measuring surface	4	reflective plane

Figure 20 — Screen to be used to simulate the wall

7.5 In-duct measurement

In-duct measurement can also be performed for circular ducts, using EN ISO 5136 standard. In this case, the duct end correction shall not be applied as the sound power level measured is directly the sound power travelling in the duct.

8 Uncertainty

Uncertainty of measurement shall be determined and recorded.

9 Test report

9.1 General information

The test report shall at least contain:

a) Publication date;

b) Date of measurement;

c) Test institute;

d) Test location;

e) Test supervisor;

f) Test object designation:

   1) Type;

   2) Serial number;

   3) Name of the manufacturer;

g) Reference to this European Standard;

h) Reference to the basic acoustic standards used.

9.2 Additional information

Additional information given on the rating plate shall be noted and any other information relevant to the tests.

9.3 Test results

Test results shall include:

— Type of configuration of the unit;

— Settings of the unit:

   — Wiring or control signal for fan speed setting;

   — Position of dampers and flaps, etc.

All data regarding the installation of the unit (duct length and size, mountings, feet, flaps position, damper, distance to the floor or walls, etc.) should be explicitly mentioned in this part.

NOTE Pictures of the installation can be provided.

— Test conditions:

   — Temperature;

   — Atmospheric pressure;

   — Relative humidity;

  - external static pressure difference;

- Results from performance tests:
  - Rotation speed;
  - Total electric power input, voltage;
  - Sound power level spectrum (dB);
  - Overall dB(A) sound power level.

10 Data to be recorded

The measuring equipment used for the test shall be recorded by the laboratory.

All the intermediate measured data and test configurations which are necessary to calculate the results shall be recorded.

11 Manufacturer's data

The manufacturer or supplier shall supply the test house with the following minimum information for every fan coil unit to identify the fan coil unit and allow its traceability.

a) Manufacturer's identification;

b) Type, model and serial number designation;

c) Mounting and operating instructions;

d) Power input in W of the fan motors at standard conditions;

e) Voltage, nature and frequency of the current.

NOTE Further information can be provided in manufacturer's documentation with regard to performance in the range of application.

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