



**ACOUSTICAL MEASUREMENTS OF FAN-COIL UNITS
IN REVERBERATION ROOM**

**ESSAIS ACOUSTIQUES DES VENTILO-CONVECTEURS
EN SALLE REVERBERANTE**

**AKUSTISCHE MESSUNGEN AN
VENTILATOR-KONVEKTOREN IM HALLRAUM**

EUROVENT

**ACOUSTICAL MEASUREMENTS OF FAN-COIL UNITS
IN REVERBERATION ROOM**

**ESSAIS ACOUSTIQUES DES VENTILLO-CONVECTEURS
EN SALLE REVERBERANTE**

**AKUSTISCHE MESSUNGEN AN
VENTILATOR-KONVEKTOREN IM HALLRAUM**

EUROVENT - 1992

First Edition 1981
Second Edition 1992

This document has been prepared by the EUROVENT WG 8 "ACOUSTICS" with the participation of the following members :

Yian CHEN	-	Switzerland
Alan FRY	-	United Kingdom
Klemens RUFF	-	Germany
Sule BECIRSPAHC	-	France

Published by EUROVENT
TECHNICAL SECRETARIAT
15 rue Montorgueil
75001 PARIS
Tel (33)1 40 26 00 85
Fax (33)1 40 26 01 26

AIMS AND OBJECTIVES

Founded in 1959, the European Committee of Air Handling and Air conditioning Equipment Manufacturers, EUROVENT, is made up of 11 national trade associations representing the manufacturers of air handling equipment in Europe :

Belgium - Germany - Spain - France - Great Britain -
Italy - Norway - Netherlands - Portugal - Sweden - Finland

EUROVENT has the aim, on a European level, to facilitate closer ties between the companies of the profession, to promote all desirable and possible exchanges between European manufacturers, and to contribute to an improvement of the profession.

EUROVENT represents the profession in relations with the European authorities and the International Organizations.

DEFINITION ET BUTS

Fondé en 1959, le Comité Européen des Constructeurs de Matériel aéralique, EUROVENT, rassemble 11 associations professionnelles nationales représentatives des constructeurs de matériel aéralique en Europe :

Belgique - Allemagne - Espagne - France - Grande Bretagne
Italie - Norvège - Pays-Bas - Portugal - Suède - Finlande

EUROVENT se propose de faciliter sur le plan européen un rapprochement des entreprises de la profession, d'aider à tous les échanges souhaitables et possibles entre les constructeurs européens et de contribuer à une amélioration des conditions d'exploitation des marchés et au développement général de la profession.

EUROVENT représente la profession auprès des autorités européennes et des organismes internationaux.

AUFGABEN UND ZIELE

Das 1959 gegründete Europäische Komitee der Hersteller von lufttechnischen Geräten und Anlagen, EUROVENT, umfasst 11 nationale Fachverbände, die die Hersteller in Europa repräsentieren.

Belgien - Deutschland - Spanien - Frankreich - Grossbritannien
Italien - Norwegen - Niederlande - Portugal - Schweden - Finnland

EUROVENT hat es sich zur Aufgabe gemacht, die Annäherung zwischen den Firmen auf europäischer Ebene zu erleichtern, beim wünschenswerten und möglichen Erfahrungsaustausch zwischen den europäischen Herstellern zu helfen, die Marktbedingungen zu verbessern und zu einer allgemeinen Förderung des Fachbereiches beizutragen.

EUROVENT vertritt die Interessen des Berufszweiges gegenüber den europäischen Behörden und den internationalen Organisationen.

TABLE OF CONTENTS

	Page
1. PURPOSE	3
2. USE OF DATA	3
3. DEFINITIONS	3
3.1 Fan-Coil unit	3
3.2 Sound pressure level L_p	3
3.3 Sound power level L_w	3
3.4 Frequency range of interest	4
3.5 Reverberant sound field	4
4. METHOD OF TESTING TO BE USED	4
5. TEST SET-UP	4
5.1 Reverberation room	4
5.2 Equipment location	4
5.2.1 - Free delivery fan-coil units	4
5.2.2 - Ducted fan-coil units	6
5.3 Test conditions	8
5.4 Operating conditions	8
6. TEST PROCEDURE	8
6.1 Measurement of sound pressure level	8
6.2 Measurement of background noise	9
6.3 Additional quantities to be measured	9
6.4 Calculation of sound power level	9
7. PRESENTATION OF THE RESULTS	9
8. REFERENCES	10

1 - PURPOSE

The purpose of this document is to describe a method for the determination of the sound power of fan coil units. The sound power level is calculated in frequency bands from sound pressure measurements in a reverberation room. This method gives no information regarding the directivity.

2 - USE OF DATA

The primary use of the sound power level data obtained from these tests is for the comparison of the noise levels generated by various units.

As the method does not yield information regarding directivity, the sound power level must be employed cautiously for the prediction of the sound pressure level. Generally reverberant sound pressure level may be reliably predicted, but near field and direct field sound pressure levels will require additional directivity information.

3 - DEFINITIONS

3.1- Fan-Coil Units

Units for the cooling and/or heating of air with air flow to the room endured by one or more electrically driven fans. Fan-coil units may be of the cabinet type within a room for free air delivery, or of the chassis type concealed within the building structure with a short duct connected to the outlet and/or inlet of the unit.

3.2 - Sound pressure level L_p

$$L_p = 20 \log_{10} \left(\frac{p}{p_0} \right) \quad (\text{dB})$$

where:

p is the mean square sound pressure (Pa)

p_0 is the reference sound pressure ($2 \cdot 10^{-5}$ Pa)

3.3 - Sound pressure level L_w

$$L_w = 10 \log_{10} \left(\frac{W}{W_0} \right) \quad (\text{dB})$$

where:

W is the sound power (W)

W_0 is the reference sound power (1 picowatt)

3.4 - Frequency range of interest

The frequency range of interest in this document includes the octave bands with centre frequencies between 125 and 8000 Hz.

125	250	500	1000	2000	4000	8000
------------	------------	------------	-------------	-------------	-------------	-------------

3.5 - 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 - METHOD OF TESTING TO BE USED

It is generally recognized that the sound spectrum of fan coil units contains discrete-frequency components which may have an important influence on the nuisance caused by the noise. The method of testing to be used is therefore that one which allows the determination of the sound power of sources emitting discrete-frequency sounds. Consequently, these test rules are based on the Standard ISO 3742.

5 - TEST SET-UP

5.1 - Reverberation room

Sound measurements of fan coil units are performed in a reverberation room, which shall be qualified for the measurement of broad-band noise according to the Standard ISO 3741. 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 according to the Standard 3742.

Even if this latter qualification is not possible, the test can nevertheless be carried out; it will, however, require more time.

5.2 - Equipment location

5.2.1 - Free delivery fan coil units

The fan-coil unit shall be placed in the reverberation room in a operating position representative of its normal usage. The distance from the floor, from the wall or from the ceiling of the room (as applicable) required for the normal air circulation pattern of the equipment shall be respected.

Except for special cases, the equipment shall not be located at less than 1.5m from any corner of the room and not on one of the center lines.

If the apparatus is equipped with feet and if no fixation is provided for, it is recommended to mechanically isolate the equipment

If the equipment is to be fixed on the floor or on the walls, any suitable device may be used taking its bearing on the fixing points provided for by the manufacturer. Any other mounting arrangement may alter the noise radiation conditions.

For floor mounted units the equipment location is shown on Figure 1.

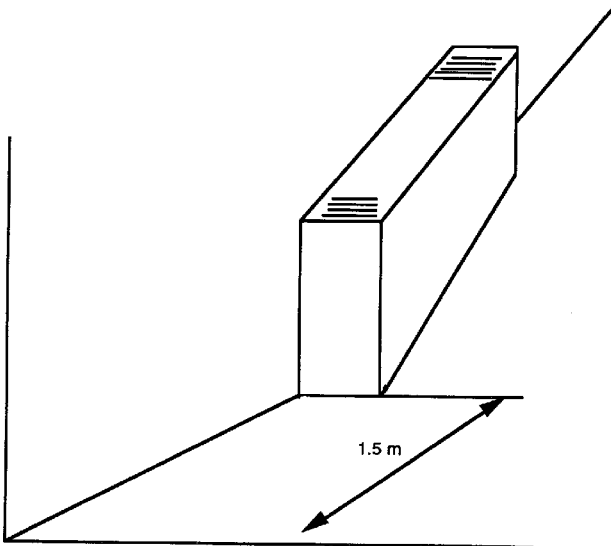


Figure 1

For ceiling mounted units a position away (by at least 1.5 m) from the walls should be employed (see Figure 2).

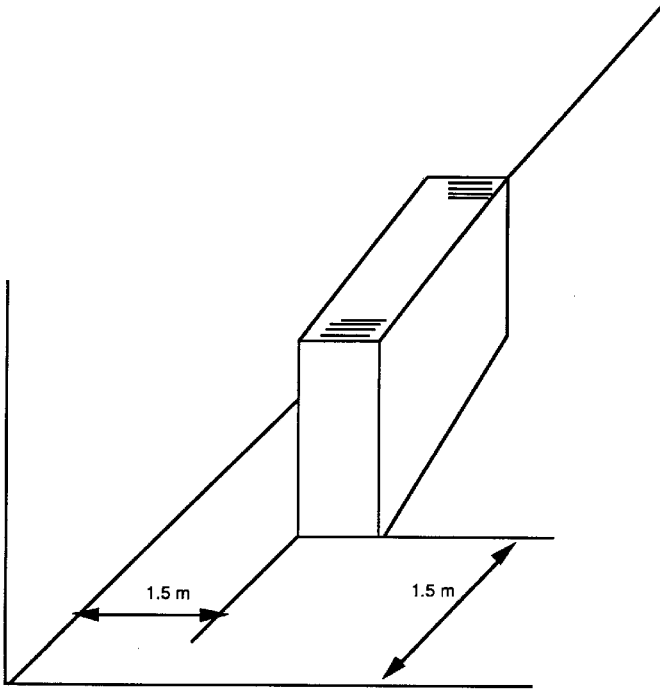


Figure 2

5.2.2 - Ducted fan-coil units

- inlet sound power,
- combined inlet and casing sound power,
- outlet sound power.

For inlet sound power the equipment shall be installed as shown on Figure 3a.

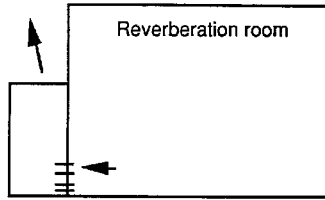


Figure 3a

For combined inlet and casing sound power, the equipment shall be installed as shown on Figure 3b.

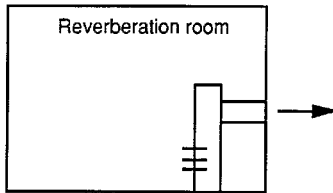


Figure 3b

For outlet sound power the equipment shall be installed as shown on Figure 3c.

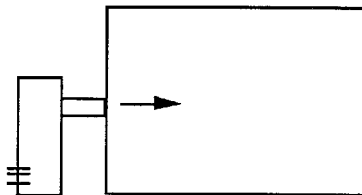


Figure 3c

The outlet duct (or ducts) shall be rigid and as short as possible and preferably less than 0.5 m terminating flush with the internal wall of the reverberation room. This outlet duct (or ducts) shall have the same cross section as the outlet of the unit. This cross section shall be reported.

The outlet duct (or ducts) shall be rigid and as short as possible and preferably less than 0.5 m terminating flush with the internal wall of the reverberation room. This outlet duct (or ducts) shall have the same cross section as the outlet of the unit. This cross section shall be reported.

5.3 - Test conditions

Acoustical measurements of fan coil units are normally carried out at zero heat load. It is therefore not necessary to connect the heating or cooling medium flows, except when a special test is required. These special tests may give rise to problems with respect to the determination of background noise and to the establishment of the heat and moisture balance.

The electrical wiring shall assure the control and the stability of the normal supply voltage of the equipment.

5.4 - Operating conditions

The fan impeller speed shall be measured and considered as a parameter fixing the working point. If this is not possible, the supply voltage shall be adjusted and maintained at the value specified by the manufacturer. The measurement of the electrical power input can then be used to determine the operating point and to control the stability of the operating conditions.

The setting of the control devices (dampers, grilles, etc.) shall be specified for each test.

For units with several rotational speeds, tests shall be performed for all the operating conditions for which results are required.

6 - TEST PROCEDURE

6.1 - Measurement of sound pressure level

The test room will be qualified according to ISO 3741. However, the test procedure will be carried out according to ISO 3742. Hence at least six measuring microphone locations will be necessary to establish the standard deviation of the sound pressure level for each octave band.

Should the value of this standard deviation conform to the qualification (Table 3 in ISO 3742) then further source locations will not be required to establish the octave band sound pressure level. Otherwise, the number of locations will be calculated using Table 3 and equation in ISO 3742.

6.2 - Measurement of background noise

The background noise level (measured without the equipment running) shall be at least 6dB, below the sound pressure level to be 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 7.2.3.

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 quantities allowing the determination of the operating point of the fan coil unit on test shall be measured (see 5.4).

6.4 - Calculation of sound power level

The sound power of the unit shall be calculated in each octave frequency band from the time and space averaged value of sound pressure measured in the reverberation room. For this calculation, the ISO standards recommend two methods:

- the direct method which requires the knowledge of reverberation time in the room.
- the comparison method, where the measured sound pressure levels are compared with the sound pressure levels produced in the same room by reference sound source of known sound power output.

7 - PRESENTATION OF THE RESULTS

The test report shall include:

For free delivery units :

- Sound power level per octave band for all operating points of the fan-coil unit.

For ducted units :

- Sound power level per octave band for all operating points of the fan-coil units specifying:
 - inlet sound power,
 - combined inlet and casing sound power,
 - outlet sound power.
- A weighted sound power level expressed in dB (A) calculated from the spectrum according to ISO 3741 Annex C for all sound powers measured.
- All indications particular to the tests and described in this document or in the before mentioned acoustical standards.

8 - REFERENCES

To perform the acoustical measurements according to this document, the requirements specified in the two following fundamental acoustical standard shall be compiled with:

1) ISO 3741:

Determination of sound power levels of noise sources - precision methods for broad-band sources in reverberation rooms.

2) ISO 3742:

Determination of sound power levels of noise sources - precision methods for discrete-frequency and narrow-band sources in reverberation rooms.

LIST OF THE MEMBER ASSOCIATIONS

BELGIUM

FABRIMETAL

Groupe 9/5

21 rue des Drapiers - B 1050 BRUXELLES

Tél. 32/2/5102311 - Fax : 32/2/5102301 - Tx 21078

GERMANY

Fachgemeinschaft Allgemeine Lufttechnik im VDMA

Postfach 710864 - D-6000 FRANKFURT/MAIN 71

Tél. 49/69/6603227 - Fax : 49/69/6603511 - Tx : 411321

SPAIN

AFEC

Asociacion de Fabricantes de Equipos de Climatizacion

Francisco Silvela, 69-1°C - E.28028 MADRID

Tel : 34/1/4027383 - Fax : 34/1/4027638

FRANCE

SYNDICAT DE L'AERAUQUE

Cedex 72 - FR 92038 PARIS LA DEFENSE

Tél : 33/1/47176292 - Fax : 33/1/47176427 - Tx : 616064

GREAT BRITAIN

HEVAC

Heating Ventilating and Air Conditioning Manufacturers

Association

Sterling House - 6 Furlong Road - GB-BUCKS SL 8 5DG

Tel : 44/628/531186/7 - Fax : 44/628/810423

ITALY

ANIMA

Associazione Nazionale Industria Meccanica Varia ed

Affine

Via Battistotti Sassi, 11 - IT-20133 MILANO

Tel : 39/2/7397.1 - Fax : 39/2/7397/316 - Tx 310392

NORWAY

NVEF

Norsk Ventilasjon og Energiteknisk Forening

P.O. Box 850 Sentrum - N-0104 OSLO 1

Tel. 47/2/413445 - Fax : 47/2/424664

NETHERLANDS

VLA

Vereniging Fabrieken van Luchttechnische Apparaten

Postbus 190 - NL-2700 AD ZOETERMEER

Tel. 31/79/531100 - Fax : 31/79/531365 - Tx 32157

PORTUGAL

APIRAC

Associação portuguesa de refrigeração e ar condicionado

R.Viriato, 5-1° - P-1000 LISBOA

Tel. 351/1/530259 - Fax : 351/1/530259 - Tx 18862

SWEDEN

The Swedish Association of Air Handling Industries

P.O. Box 55 06 - S-11485 STOCKHOLM

Tel. 46/8/7838000 - Fax : 46/8/6603378 - Tx 19990

FINLAND

AFMAHE

The Association of Finnish Manufacturers of Air Handling
Equipment

Eteläranta 10 - SF-00130 HELSINKI

Tel : 358/0/19231 - Fax : 358/0/624462 - Tx 124997