



EUROVENT / CECOMAF



EUROVENT 8/5 - 1993

**ACOUSTICAL MEASUREMENTS OF AUTONOMOUS
AIR CONDITIONING UNITS IN REVERBERATION
ROOMS**

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FOREWORD

Autonomous
Autonomous air conditioning units are built either as packaged units or as split systems.

In this latter case the compressor and the evaporator are arranged together as a unit inside the building, while the condenser is outdoors.

Thermal testing of these units is covered by EUROVENT document 6/6* where additional information is available.

The acoustical testing of these units gives rise to some problems due both to the size of the equipment and to the need for thermal compensation.

For units with up to 25 kW cooling power it is recommended to use a reverberation room test method.

This document provides the specifications needed in this case.

For larger units for which the thermal compensation becomes a problem, it is recommended to use a free field test method.

EUROVENT document 8/1 provides the specifications needed in this case.

* EUROVENT 6/6
Packaged Air Conditioning Units

1. PURPOSE AND SCOPE

The purpose of this document is to describe a method for the determination of the most important acoustical characteristics of autonomous air-conditioning units. These units supply air to the space to be conditioned either with or without ducting.

According to the equipment the tests to be carried out are :

- a/ For units without ducting the total sound power level generated by the supply air terminal devices and the casing shall be determined by testing the unit in a reverberation room as shown in fig. 1a et 1b.

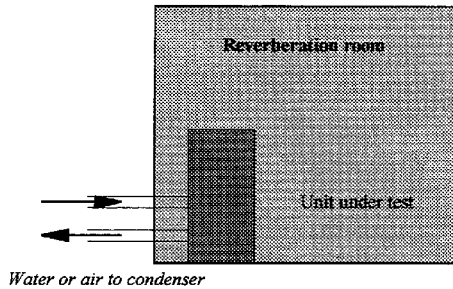


FIG. 1a

*Testing of units without ducting
(packaged units)*

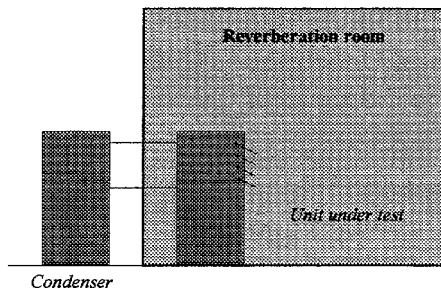


FIG. 1b

*Testing of units without ducting
(split systems)*

- b/ For units with ducted outlet, the sound power level radiated by the casing only shall be determined by testing the unit in a reverberation room with the ductwork arranged as shown in fig. 2a et 2b.

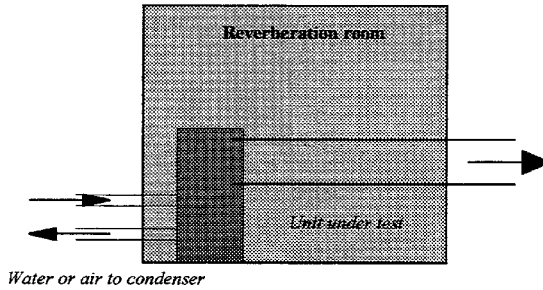


FIG. 2a

Testing for casing sound power level for units with ducted outlet (packaged units)

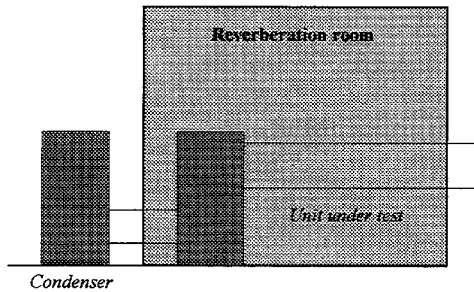


FIG. 2b

Testing for casing sound power level for units with ducted outlet (split systems)

- c/ For units with ducted outlet, the sound power level radiated into the outlet duct shall be determined by testing the unit located outside a reverberation room with the ductwork extending into the room as shown in fig. 3a et 3b.

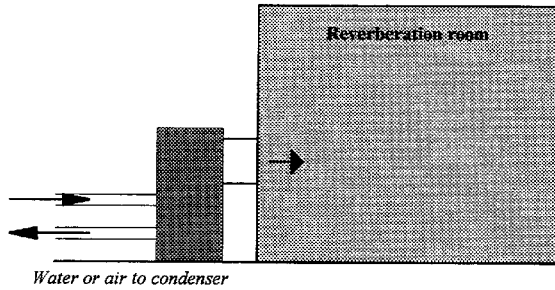


FIG. 3a

*Testing for ducted sound power level
(packaged units)*

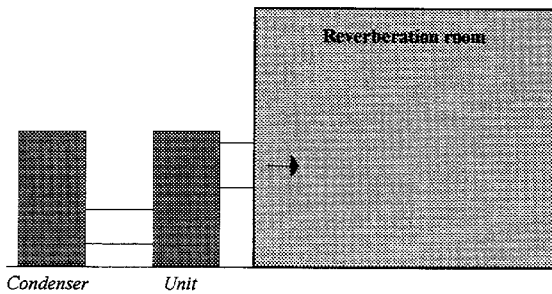


FIG. 3b

*Testing for ducted sound power level
(split systems)*

2. USE OF DATA

The primary use of the sound power level data obtained from these tests is for 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 Autonomous air-conditioning unit.

This is equipment designed to provide conditioned air to an enclosed space. It includes mainly a source of refrigeration for cooling and déhumidification, and a means for the circulation and cleaning of air. The refrigeration power of these units is generally between 10 kW and 50 kW.

This document does not apply to packaged room air conditioners covered by the document 8/4.

3.2 Sound pressure level L_p

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

where

p is the mean square sound pressure (Pa)

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

3.3 Sound power 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 (10^{-12} W)

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
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4. TEST SET-UP

4.1 Reverberation room

Sound measurements of autonomous air-conditioning units are performed in a reverberation room which shall be qualified for the measurement of broad-band noise according to Appendix A of Standard ISO 3741.

4.2 Installation of the equipment

Generally the unit shall be placed in the reverberation room (fig. 1 and 2) in an operating position representative of its normal usage. The distance from the floor, from the wall or from the ceiling of the room required for the normal air circulation pattern of the equipment shall be respected.

The installation of the equipment shall be achieved by using the parts supplied by the manufacturer. The specified fixing points are to be respected. For the installation of air-cooled units the manufacturer's specifications relative to the air inlet and outlet connections through the partition shall be followed.

When testing for the casing sound power level of units with ducted outlet (fig. 2), it is recommended that the duct be made of relatively heavy material or acoustically lagged. This is in order to reduce the noise radiated from the wall of the outlet duct.

When testing for the outlet sound power level of units with ducted outlet (fig. 3), the duct should be as short as possible and preferably less than 0.5 m, terminating flush with the internal wall of the reverberation room. This outlet duct shall have the same cross section as the outlet of the unit. This cross section shall be reported.

4.3 Operating conditions

Since the autonomous air-conditioning unit includes a refrigerating compressor it must be tested with this compressor operating. The air temperature shall be maintained between 20° and 30°C. There is not need for humidity control.

The measurements should be performed at steady environmental conditions which shall be recorded.

The noise caused by any compensation equipment will belong to the background noise and care must be taken that it remains within the limits allowed by the fundamental acoustical Standard ISO 3741.

The equipment to be tested shall operate in a well defined manner. The position of any mobile elements (dampers, grilles, etc...) shall be recorded for each test.

The supply voltage shall be adjusted to the nominal value specified by the manufacturer and maintained at this value within the tolerance limits given in document 6/6. This value shall be measured and reported.

5. TEST PROCEDURE

5.1 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 (*table n° 3 in ISO 3742*) then further microphone test locations will not be required to establish the octave band sound pressure level.

Otherwise the number of locations will be calculated using table n° 3 and equation 3 in ISO 3742.

5.2 Measurement of background noise.

The background noise level, measured without the equipment running, shall be at least 6 dB 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 ISO 3741 Par. 7.2.3.

5.3 Calculation of sound power level.

The sound power level of the unit shall be calculated in each octave frequency band from the time and space averaged value of sound pressure level 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 a reference sound source of known sound power output.

The determination of the reverberation time* of the room for the direct method, or the room for the direct method, or the measurements using the reference sound source for the comparison method shall be performed at the same environmental conditions in the test room (temperature, humidity) as for the measurements of the equipment under test.

5.4 Additional quantities to be measured.

In addition to the quantities defined in the acoustical standard required for the calculation of the acoustical characteristics, all quantities allowing the determination of the operating point of the autonomous air conditioning unit under test shall be measured (*see 4.3*).

* *This determination may be performed according to the Standard ISO/R 354 (Measurement of absorption coefficients in a reverberation room).*

6. PRESENTATION OF RESULTS

The test report shall include for all selected operating points :

- sound power level radiated by the autonomous air conditioning unit without ducting (fig. 1a et 1b).
- sound power level radiated (fig. 2a et 2b).
- sound power level radiated from the duct outlet when testing a ducted autonomous air conditioning unit (fig. 3a and 3b). No duct end reflection correction shall be applied in this test.

The following data shall be reported :

- levels per octave band,
- A-weighted levels calculated from only these octave band levels.

7. REFERENCES

To perform the acoustical measurements according to this document the requirements specified in the two following fundamental accoustical Standards shall be followed :

a/ ISO 3741

Détermination of sound power level of noise sources :
Precision method for broad-band sources in reverberation rooms.

b/ ISO 3742

Determination of sound power level of noise sources :
Precision method for discrete frequency and narrow-band sources in reverberation rooms.

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