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**ACOUSTICAL MEASUREMENTS OF
AIR-COOLED PACKAGED ROOM
AIR CONDITIONERS IN
REVERBERATION ROOM**

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1. PURPOSE AND SCOPE

The purpose of this document is to describe a method for the determination of the most important characteristics of air-cooled packaged room air conditioners.

These units may be mounted either in an aperture in the outside wall of a building (*windows air conditioner*) (*figure 1*) or on a console (*console air conditioner*) (*figure 2*), in this latter case, only the air inlet and outlet of the condenser circuit are visible on the outside wall.

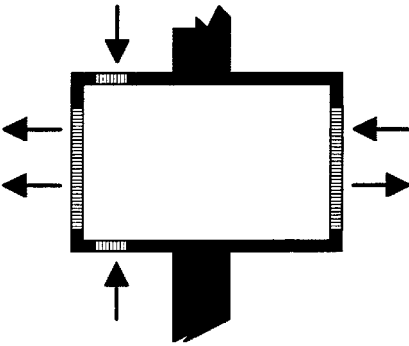


Figure 1

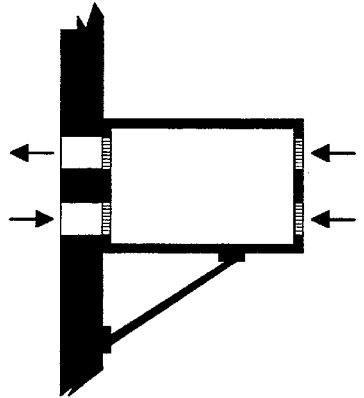


Figure 2

For these types of room air conditioners the acoustical characteristics to be determined by the tests are :

- a/ The sound power radiated directly to the room,
- b/ The sound power radiated to the outdoors,
- c/ The attenuation of the noise coming from outdoor (sound insulation).

Regarding sound power, the test rules outlined in this document are based on the fundamental acoustical Standard ISO 3742.

The sound power levels are calculated in frequency bands from sound pressure measurements performed in a reverberation room.

This method, no information regarding 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 Room air-conditioner

Equipment designed to provide free delivery of conditioned air to an enclosed space. It includes mainly a source of refrigeration for cooling and dehumidification and means for the circulation and the cleaning of air.

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

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

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 room air conditioners 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

The installation of the equipment shall be achieved by using the parts supplied by the manufacturer. The specified fixing points are to be respected. To support the window air conditioner, the partition itself may be used if it is made in heavy masonry (*figure 3*).

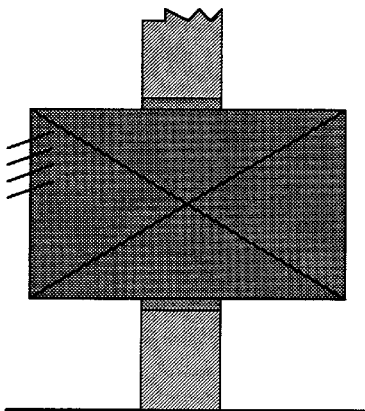


Figure 3

**Example for the installation of a window air conditioner
on a "heavy" partition**

Alternatively if a support has to be arranged which ground (*figure 4*), any undue stressing of the equipment casing should be avoided

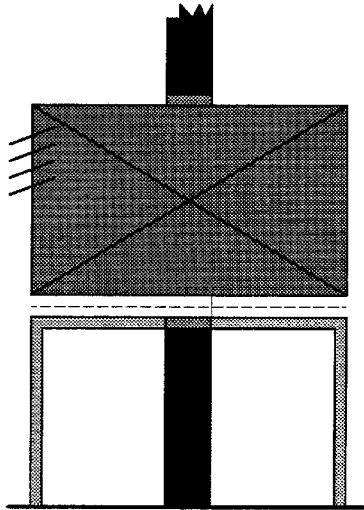


Figure 4

Example for the installation of a window air conditioner with support

For the installation of air-cooled console air conditioners, the manufacturers' specifications relative to the air inlet through the partition shall be followed

4.3 Operating conditions

Since the room air conditioner includes a refrigeration compressor it must be tested with this compressor operating.

The temperature and humidity must be maintained on both sides of the unit to keep the unit working within its normal operating range.

The measurements shall be performed at steady environmental conditions which should 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 the mobile elements (*dampers, grilles etc...*) shall be recorded for each test.

The supply voltage shall be adjusted to the value specified by the manufacturer and maintained at this value.

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 conform to the qualification (*table n° 3 in ISO 3742*) then further room air conditioner 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 the ISO standard 3741, par. 7.2.3.

5.3 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 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 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 Measurement of sound insulation.

A broad-band noise source shall be installed in the room on the outdoor side of the equipment. The sound power of this source shall be high enough to insure that the sound pressure levels measured in the second room exceed those of the background noise in each frequency band by at least 6 dB and, if possible, by more than 12 dB (background noise for this test is determined with the equipment under test and the compensation devices stopped).

The insulation test is performed by measuring the mean sound pressure levels in octave bands in both rooms : L_{p1} in the source room and L_{p2} in the receiving room with the broad-band noise source running and the equipment under test and the compensation devices stopped. The source room microphone locations will be in a zone between 1 m and 2 m from the geometric centre of the unit under test and not closer than 1 m from the mounting surface. At least three locations will be employed.

To calculate standard insulation D_n , it is necessary to know the value of the receiving rooms reverberation time, T_r , for each octave band..

Standard insulation is defined by the expression :

$$D_n = L_{p1} - L_{p2} + 10 \log \frac{T_r}{T_o}$$

where

T_o is the reference reverberation time equal to 0,5 s.

5.5 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 room air conditioner under test shall be measured (*see. 4.3*).

6. PRESENTATION OF RESULTS

The test report shall include :

- Sound power radiated directly to the room for all selected operating points of the room air conditioner.

The following data shall be indicated :

- levels per octave band
 - a-weighted level calculated from the spectrum.
- Sound power radiated to the outdoors for all selected operating points of the room air conditioner.

The following data shall be indicated :

- levels per octave band
 - a-weighted level calculated from the spectrum
- Standard sound insulation
- All indications particular to the tests and described in this document or in the fundamental acoustical Standard.

7. REFERENCES

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

a/ ISO 3741

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

b/ ISO 3742

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

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