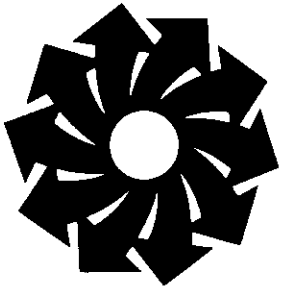


**Real Room
Acoustic
Test
Procedure**



**HEVAC
ASSOCIATION**

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FOREWORD

by Mr. Alan Fry

Chairman of the HEVAC Acoustics Group

Acoustic testing has always been associated with comparatively expensive and certainly specialised facilities often involving large test rooms. In contrast to this, the standard high quality sound level meter, which is readily available, is now reliable and inexpensive. At the same time many people use these instruments in standard everyday situations to yield relevant real-life information, usually presented in sound pressure levels measured in decibels — dB.

The HEVAC Association Acoustics Group realised a need for some form of standardisation for this real-life situation and from a sheet of white paper created a completely original standard test procedure, yet at the same time kept economy in mind. The procedure had to have credibility and produce useful data. To this end, the document is written completely around sound pressure level measurements in contrast to specialised test laboratories' reference to sound power levels. However, the procedure retains a measure of noise directivity information and simulates an average furnished environment. To aid laboratory repeatability the real room is specified in size and acoustic environment.

The document will be of significant interest to consultants and specifiers as the results will be immediately applicable for their real-life situations. Quality assurance is one area where the procedure can be utilised for low cost product assessment.

The unusual feature of the procedure's inception is that it has been written by the HEVAC Acoustics Group for the benefit of other product groups. Members of these other product groups also provided expertise to supplement the specific product knowledge.

Initially only twelve product groups and corresponding appendices are included, but more will be developed as requested.

SUMMARY

For most of the products manufactured for the heating, ventilation and air-conditioning industry no specific test code existed for the assessment of the noise levels generated by these products. Consequently it was often not possible to compare the noise levels of different products on a realistic basis, or reliably estimate the noise levels of such products when installed in their operating environment. This test code was prepared in order to provide a reasoned means of comparison between products and to enable purchasers of such equipment to estimate the noise levels which would be generated by the installed equipment.

The demands made by this code on the provision of special test environments, measurement equipment and measurement procedures have deliberately been minimised. Consequently the accuracy of determination of noise radiated by the product, according to this code, is less than could be achieved by following more stringent procedures such as those outlined for example in BS 4196 : Parts 1-6 or BS 848 : Part 2. However it is felt that the resultant accuracy implicit in this code will be sufficient to compare different products on a realistic basis and that by introducing the concept of the "REAL ROOM" estimates of the sound pressure levels in an installation can be easily derived.

It is not intended that this lower precision test code should replace the existing precision standards but should, where it is appropriate, supplement them.

The accurate determination of the noise produced by a piece of equipment, if it is carried out in accordance with the various national and international test codes and standards, is costly, requiring the use of expensive facilities, equipment and skilled personnel, which may not be readily available to many manufacturers.

In many cases, however, the precision of the international standards is not called for and it is considered that there is a place for a test code which, although giving results of lesser accuracy than the existing codes, would give answers which were sufficiently repeatable to enable them to be used for the following purposes.

- a) To allow a manufacturer to assess the effect of changes in the design of his products, on the noise that they generate.
- b) To give a manufacturer some assurance, before he goes to the expense of submitting his product for noise measurement by an acoustic laboratory, that there is a reasonable chance that his equipment will meet the criteria that he is trying to achieve.
- c) There are many products for which it is not customary to undertake tests to the full high precision standards, mainly because the cost of the products and the quantity sold, do not justify the expense of the full test. If sound figures are quoted at all, they are obtained from tests carried out in a non-standard and arbitrary way. By laying down a method which is cheap enough for the makers of such products to use, it will help to ensure that the tests on these products are carried out under controlled conditions.
- d) To broadly compare one product with another.

This code was prepared by members of the HEVAC Acoustics Group.

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0 INTRODUCTION

The assessment of noise from machines or equipment requires effective exchange of acoustic information among the several parties concerned. These include the manufacturer, specifier, installer and user of the machine or equipment. This acoustical information is obtained from measurements. These measurements are useful only if they are carried out under specified conditions, using standardised instruments, to obtain defined acoustical quantities. This code describes the acoustical conditions for the noise measurements and the procedures to be used for specific ranges of products manufactured for and used in the heating, ventilating and air-conditioning industry. This code introduces the concept of REAL ROOM testing which involves testing in an environment typical of the eventual product installation, in contrast to many standard procedures which require the construction of specialist acoustic rooms, for example anechoic or reverberant chambers. The environment is described in this code as 'REAL ROOM' and in many cases a satisfactory environment can be created in an existing office or workshop area.

Very close to a noise source is an area known as the acoustic near field in which sound pressure levels are not representative of the noise radiated away from the source. Beyond this region and in a completely open environment sound from a source is radiated away with the sound pressure level decreasing at a rate of 6 dB per doubling of distance. Such conditions are found in specialist acoustic rooms known as anechoic chambers. In a completely closed environment in which the walls are highly reflective, noise from a source would build up and become uniform throughout the room. Such conditions are found in specialist acoustic rooms known as reverberation chambers. In an ordinary room the walls, floor and ceiling are generally only moderately reflecting. In such a room sound pressure levels measured reasonably close to the source but beyond the near field are dominated by the radiated noise and are influenced to a lesser extent by reflected noise. The specifications of the real room in this code are set to constrain the influence of the environment within reasonable limits thereby enabling a realistic comparison of sound pressure levels measured in different real room environments. Sound power levels cannot be derived using this real room code.

1 GLOSSARY

Sound	Mechanical disturbance, propagated in an elastic medium, of such character as to be capable of exciting the sensation of hearing.
Noise	Sound which is undesirable by the recipient.
Sound pressure level	The sound pressure level (abbreviation L_p) of a sound, in decibels, is equal to 10 times the logarithm to the base 10 of the ratio of the mean square sound pressure to the square of the reference sound pressure. The reference sound pressure in air is 20×10^{-6} Pa.

'A' weighted pressure level	When measuring a sound, an instrument which duplicates the ears variable sensitivity to sound of different frequencies is often used. This is achieved by building in filters to the instrument with a similar frequency response to that of the ear. This is called an 'A' Weighting Filter. Measurements of sound pressure level made with this filter are called 'A' Weighted Sound Pressure Level measurements, and the unit is the dBA.
Band pressure level	The sound pressure level of the sound energy within a specified frequency band.
Octave band	A range of frequencies whose upper limiting frequency is twice the lower limiting frequency. In this specification it is identified by the geometric mean frequency of the range as set out in 5.1.2.
Reverberation time	The period of time (T) required for the mean square sound pressure in the Real Room, initially in a steady state, to decrease, after the source is stopped, to one-millionth of its initial value, i.e. by 60 decibels. The unit is the second.

2 SCOPE AND FIELD OF APPLICATION

2.1 Scope

The real room test method described may be applied for the acoustic rating of products in the heating, ventilating and air conditioning fields. Specific products covered by this standard are listed in the appendices; see Contents page. Other products not specifically listed may still be rated by following the general principles and procedures specified in this standard. In general, products with dimensions greater than $1.4\text{m} \times 1\text{m} \times 1\text{m}$ are excluded except where the individual appendix applicable to the product permits otherwise. It is possible that sound pressure levels measured according to this code may not at present be accepted as evidence that products comply with requirements stipulated by British Government, EEC, or other legislation.

2.2 Field of Application

The sound pressure levels derived by the real room test method may be used to

- enable a manufacturer to compare the noise levels of similar products,
- enable a user, specifier, consultant or contractor to compare the noise levels of similar products from different manufacturers,
- enable those responsible for the selection of equipment to estimate the noise levels of the product when used in a domestic, commercial or industrial environment.

3 STATEMENT OF ACCURACY

The variation allowed between individual 'real rooms' means that there will be differences of up to 4 dB between the sound pressure levels which would be generated by the same product tested in a range of real rooms. The repeatability of measuring an individual item of equipment in one particular room is likely to be within ± 1 dB. If the noise from the product is particularly tonal or is strongly directional the repeatability may not be better than ± 3 dB.

It should be noted also that individual items of a given product line will also have a spread of sound levels. Since the code is seeking to determine sound levels of a product line consideration must be given to the problem of allowing a tolerance for individual variation. This shall be done by testing three or more samples of the product, taking the arithmetic mean real room sound pressure level and quoting a tolerance on this level.

4 REAL ROOM REQUIREMENTS

4.1 Room Size

The test room shall lie within the following dimensions:

Height	2.8 — 3.2 m,
Width	3.4 — 3.8 m,
Length	Not less than 4.0 m.

4.2 Criteria for Adequacy of Test Room Environment

The ratio of the reverberation time, T (s), to the room volume, (m^3), shall lie within the following range

$$0.004 < T/V < 0.015 \text{ s/m}^3.$$

for each octave frequency band over the range 125-4000 Hz inclusive.

Some examples of rooms meeting the requirements of this procedure are as follows:

Room size H x W x L	Room volume V	Required range of reverberation time 'T' (= 0.004 V to 0.015 V)
m	m ³	s
2.8 x 3.4 x 4	38	0.15 to 0.57
3.2 x 3.8 x 4	49	0.20 to 0.73
3.0 x 3.6 x 5	54	0.22 to 0.81

The reverberation times may be established using BS 3638. (If appropriate the services of an Acoustic Consultant may be sought).

As a rough guide a room decorated to a standard equivalent to a comfortable office will normally satisfy the above criteria. Provided that furnishings remain substantially unchanged, a single test of reverberation times should suffice, for example on first commissioning the room. Except where the testing of specific products specifies otherwise (see appendices) the preferred construction and decoration is as follows:

- a the ceiling should be acoustically tiled,
- b the floor should be carpeted,
- c the total area of any glazing should not exceed 20 per cent of the wall surface area,
- d the room should be empty of furniture,
- e the reverberation times of the real room may be adjusted to within the required range values by the addition of wall treatments, curtaining etc.

Note: Further constraints on the test room design may arise with respect to background noise levels, the product performance and its installation.

5 INSTRUMENTATION

5.1 Noise Measurement

The noise measuring equipment shall consist of a microphone, its associated power supply and a frequency analyser with the facility for the measurement of dBA.

The following Clauses 5.1.1-5.1.3, are satisfied if a Sound Level Meter to BS 6698, 'Integrating Averaging Sound Level Meters', Type 0 or 1 is used, fitted with an octave band filter set to IEC 225 covering the 63-8000 Hz bands. A sound level meter complying with the older BS 5969 (or BS 4197) is also suitable if of class 1, but should for preference be fitted with a free-field calibrated microphone (see Section 5.1.1. below).

Note: BS 6698 supersedes BS 5969 (IEC 651).

The close proximity within the sound field (the real room) of an observer to the microphone can affect the levels measured. Therefore, it is preferable that an extension cable of, say 3 to 10 m in length be fitted to the microphone to enable the observer and the body of the instrument to be remote from the microphone, or better still be outside the 'real room', during the actual measurement periods.

5.1.1 Microphone

A condenser microphone or the equivalent in accuracy, stability and frequency response shall be used. The microphone shall have a flat frequency response for free field normally incident sound over the frequency range 50 Hz to 10 kHz. When used in conditions where there is moving air the microphone shall be fitted with a windshield. The preferred type of windshield is a polyurethane foam ball.

Note: The microphone is specified as being a normal incidence free-field calibrated device since it has slight advantage for direct sound paths, head-on to the microphone. This helps to minimise the effect of variation in the reverberation times between 'real rooms'. The older standards offered a choice of pressure or free-field calibrated microphones, but only a free-field microphone is specified in the latest standard, BS 6698. A $\frac{1}{2}$ -inch microphone should be used in preference to a 1-inch microphone, unless microphone self-noise is a problem for an abnormally low-noise product.

5.1.2 Frequency analyser

The frequency analyser shall have an octave band filter-set meeting the requirements of IEC 225. This can be checked by referring to the manufacturer. The nominal

centre frequencies of the octave bands shall be as given in IEC 225. Specifically, the centre frequencies shall be:

63, 125, 250, 500, 1000, 2000, 4000, 8000 Hz.

Also included in the analyser is the facility for direct dBA measurement. This real room procedure requires measurements in each of these bands, 63-8000 Hz inclusive, together with the dBA measurement.

5.1.3 Frequency response of the instrument system

The frequency response of the instrumentation for free field incident sound shall satisfy BS 5969 or an alternative specification from those listed in Section 5.1. This can be checked by referring to the manufacturer. No corrections for frequency response need be applied to the measured octave band levels. This is because in general no individual corrections are provided with type 1, 2 & 3 sound level meters, and a type 0 would have negligible corrections. Also, the angle of incidence of sound on the microphone of $\pm 30^\circ$ from the reference direction changes the sensitivity by a maximum of 2.5dB (type 0) and 4dB (type 1) at 8000Hz. Types 2 & 3 are not quoted at 8000Hz.

5.1.4 Calibration of the instrument system

For each series of tests the entire measurement system shall be calibrated by applying an acoustic calibrator to the microphone immediately before and immediately after each series.

5.1.5 Correction for ambient conditions

Provided the entire measurement system, including the microphone, is calibrated as in 5.1.4 no corrections for ambient temperature and pressure are necessary.

5.2 Air Pressure Measurement

For the purposes of real room testing, all pressure measurements shall be made with an inclined gauge or pressure transducer that has a suitable range and scale. The instrument should be calibrated to an accuracy of ± 5 per cent full scale.

The instrument shall be set to zero before each test and checked for zero after each test.

5.3 Air Velocity Measurement

Velocity measurement shall be carried out in accordance with the methods set out in BS 1042 : Part 2 : Sections 2.1 and 2.2.

6 INSTALLATION AND OPERATION OF THE PRODUCT

6.1 Positioning of Product

The product under test shall be positioned within the room according to the requirements specified in the appropriate appendix.

6.2 Auxiliary Equipment

Care shall be taken to ensure that any electrical conduits, piping or air ducts connected to the product do not radiate amounts of sound energy into the test room which will interfere with the noise from the product under test. Attention should also be given to possible sources of noise such as fluorescent lights within the room.

6.3 Operation of the Product During Measurements

During the acoustic measurements the product shall be operated in a manner typical of normal use (see appendices). Where appropriate, measurements should be taken over a range of operational conditions consistent with the manufacturers recommendations (eg flowrate and/or temperature and/or pressure differential).

6.4 Control of Operating Conditions

Care shall be taken to ensure that the flow of air into and/or out of the test room is adequately silenced to prevent noise from the flow control or flow measurement equipment interfering with the noise from the product under test. Appropriate test conditions, as specified in the appendices, shall be measured and maintained steady during the noise test.

For some products quite high pressures may be developed across the walls of the real room. Care should be taken to ensure that the construction of the room is sufficiently robust.

For some products, especially those with small low-powered fans, it shall be necessary to operate the product for a sufficient length of time to ensure that the unit achieves a steady and stable speed.

6.5 Measurement of the Operating Conditions

The operating conditions shall be measured according to the requirements appropriate to the product under test and specified in the relevant appendix.

7 MEASUREMENT OF SOUND PRESSURE LEVELS

7.1 Location of Microphone

The microphone shall be positioned, in turn, at the locations specified in the appropriate appendix. The microphone shall be positioned so that it points at the central area of the product. The microphone must be at least 1 m from any reflecting objects.

The microphone should, preferably, be fitted with an extension cable or at least a goose-neck onto the portable sound level meter or other analyser. A tripod mounting of the microphone is preferable. The person reading the sound level meter, or other analyser, shall be positioned to the rear of the microphone and as far back

from it as practicable, otherwise he may interfere with the measurement of the noise from the product under test.

7.2 Period of Observation

Sound pressure level measurements shall only be taken when the product is operating under steady conditions. An analysis system which meets the requirements of Section 5.1.3 shall be used with the 'S' or 'slow' meter setting. For each of the octave frequency bands, centre frequencies 63 to 8000 Hz, and for the broad-band dBA-weighted level, the period of observation shall be not less than 10 seconds.

7.3 Identification of Discrete Tone Noise Components

If discrete tones are detectable by ear their presence shall be reported.

The contribution of a discrete tone will be automatically included in the measured octave band levels, but it may not be apparent as a peak in the recorded data.

7.4 Background Noise Levels

With the product under test inoperative, but with all auxiliary equipment operating, measurements of the background sound pressure levels shall be taken immediately before and immediately after each set of measurements.

If the sound pressure level measured in any octave band with the product operating is not more than 6 dB greater than the background noise the sound pressure level measurement in that octave band is invalid.

Nevertheless, if three or less octave bands are affected and these are at least 6 dB below the highest octave band level for the product operating then the results may be reported for the product and the ambient noise contaminated octave band levels identified.

Note 1: Attention should be paid to any noise sources of an intermittent nature which may be present during the testing of the source but not during the assessment of the background noise. For example, cars moving past the room, doors banging, a telephone ringing, intermittently operated plant machinery etc.

Note 2: For certain devices such as air terminal devices, air control devices and induction units, background noise from the air supply fan may be checked by the following procedure. An attenuator giving at least 5 dB attenuation in all frequency bands of interest shall be inserted upstream of the terminal device. If the change in level is less than 1 dB this ductborne noise is sufficiently low to permit testing of the device according to this code. The attenuator should remain in position for the tests on the product. Full details of the test procedure are given for each product classification in the appendices.

8 CALCULATION OF PRODUCT SOUND PRESSURE LEVEL

8.1 Average Measured Sound

Pressure Level

For each octave frequency band an average sound pressure level L_p dB re 20×10^{-6} Pa shall be calculated from the formula:

$$\bar{L}_p = 10 \text{Log}_{10} \left\{ \frac{1}{N} \sum_{i=1}^N \text{antilog} \left[\frac{L_{pi}}{10} \right] \right\}$$

where N is the number of microphone positions at octave band frequency f , and L_{pi} is the octave band sound pressure level at the i -th measuring position.

This average sound pressure level is called 'the real room sound pressure level of the product', and is to be calculated for each of the octave bands specified in Section 5.1.2.

8.2 Average Measured A-weighted Sound Pressure Level

The broad-band dBA-weighted sound pressure level for each measurement position shall be averaged using the formula:

$$L, \text{ dBA} = 10 \text{Log}_{10} \left\{ \frac{1}{N} \sum_{i=1}^N \text{antilog} \left[\frac{L_{pi, \text{ dBA}}}{10} \right] \right\}$$

where N is the number of microphone positions, and L_{pi} , dBA is the broad-band dBA-weighted level obtained for the i -th measurement position.

L , dBA, is the real room overall A-weighted sound pressure level of the product.

8.3 Directivity

When a reading of the sound pressure level in a particular octave band differs from the average sound pressure level in any octave band by 3 dB or more then the product shall be reported as having directional characteristics.

9 INFORMATION TO BE RECORDED

The following information, when applicable, shall be compiled and recorded for all measurements made according to this code.

9.1 Product Under Test

- a The name of the manufacturer of the product, it's description and its accessories including the dimensions.
- b The operating conditions, for example pressure, flowrate, speed setting, supply voltage and frequency, thermal loading parameters, mechanical settings etc.

9.2 Real Room Environment

- a A description of the test environment including dimensions, description of the physical treatments on the walls, floor and ceiling and indicating any curtaining.
- b Location of the product in the test room.
- c A description of the mounting or support installation of the product including details of ancillary equipment used.
- d Air temperature, and the differential pressure, between the outside and the inside of the room.
- e Details of the electrical supply including the measured voltage and the nominal frequency.

9.3 Instrumentation

A description of equipment used to measure the sound pressure levels and to determine the aerodynamic duty of the product during the acoustic test including types, serial numbers, manufacturers, method and date of last calibration.

9.4 Acoustic Data

- a The measured sound pressure levels in each octave frequency band 63 to 8000 Hz, also the broad-band dBA-weighted sound pressure level, at each measurement position with the product under test operating.
- b The measured background sound pressure levels in each octave frequency band over the range 63-8000 Hz and the broad-band dBA-weighted sound pressure level with the product under test inoperative, but with all necessary auxiliary equipment operating.
- c The 'real room sound pressure level of the product' in each octave band over the range 63-8000 Hz, according to the averaging procedure of Section 8.1, and the broad-band dBA-weighted sound pressure level according to Section 8.2.
- d The date and time when the measurements were performed.

- e Remarks on the directivity of the noise from the product and the subjective impression of the noise eg audible discrete tones, low frequency rumbles, throbs, whistles, whines, hisses, rattles; fluctuation in pitch or amplitude.

10 INFORMATION TO BE REPORTED

- a The report shall state that the real room sound pressure level of the product has been determined in accordance with the specifications of this code.
- b The report shall state the 'real room' octave band sound pressure levels in decibels relative to 20×10^{-6} Pa and the operating duty to which they correspond, over the normal range of product operating duties. Any contaminated levels as determined in accordance with 7.4 shall be identified.
- c The report shall state the real room overall dBA-weighted sound pressure levels in decibels relative to 20×10^{-6} Pa and the operating duty to which they correspond over the normal range of product operating duties.
- d The report shall state the distance from the product at which the sound pressure measurements were taken.
- e The report shall state whether the product has directional noise characteristics.
- f The report shall state the subjective impression of the product noise.
- g The report shall state any special features.

The information to be presented on any one product is dependent on the product type. Reference should be made to the appropriate appendix for further guidance.

APPENDIX A

DOMESTIC POWERED ACOUSTIC VENTILATORS

A.1 SCOPE

This section is concerned with the measurement of noise produced by cased fan-powered ventilator units, with or without heater units and supplying either fresh, tempered or recirculated air into the room space. Provision is also made for units which are fitted to extract air only from the room. Note that this excludes the sound reduction performance of the unit itself, which is covered by Statutory Instrument 1973 No 1363.

A.2 INSTALLATION AND OPERATION

A.2.1 Mounting Procedure

The unit under test shall be mounted on a 12.5 mm thick plywood panel on timber studding. The vertical studs shall be at not more than 600 mm centres with horizontal cross bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel. The mounting height shall be one metre from the floor to the centre of the air discharge grille. Some units designed for extracting air frequently have the extract grille mounted horizontally in the base of the unit. In such cases the mounting height of one metre shall be to this reference plane.

A.2.2 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

A.2.3 Operation During Tests

The fans used in such units are generally powered by small shaded-pole motors whose speed often varies considerably with even minor variations in mains voltage, therefore this mains voltage should be measured.

It is essential to start and run the unit for a minimum warm-up period of 30 minutes until steady-state running conditions are reached prior to commencing the tests.

A.2.4 General

Any accessories which are normally part of the standard unit such as grilles and anti-backdraught shutters shall be fitted.

If the product is normally supplied with a speed control, then this shall be fitted and, in case of a stepped speed control, noise measurements carried out at each of the control settings and recorded separately. If an infinitely variable speed control is usually supplied noise measurements shall be made at full-speed and at three-quarter and half of the maximum speed, and the data recorded separately.

Where a reversing facility is normally provided, then noise measurements shall be made with the fan operating in both the supply and the exhaust modes, and the data recorded separately.

A.3 NOISE MEASUREMENT

A.3.1 Location of Measurement positions

Six microphone positions shall be used at one metre distance from the outlet-air plane. Three positions shall be at 45° intervals in the horizontal plane the centre position being directly in front of the vertical centre line of the unit and three positions at 45° intervals in the plane 45° above the horizontal, as in Fig. A.1.

A.3.2 Measurements of Sound Pressure Level

Sound pressure levels in each of the octave bands over the range 63-8000 Hz shall be recorded at each measuring position.

A.3.3 A-weighted Broad-band Sound Pressure level

The A-weighted broad-band sound pressure level dBA, shall be recorded at each measuring position.

A.3.4 Background Noise Levels

Background levels in each octave band at each measuring position shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

A.4 INFORMATION TO BE PRESENTED

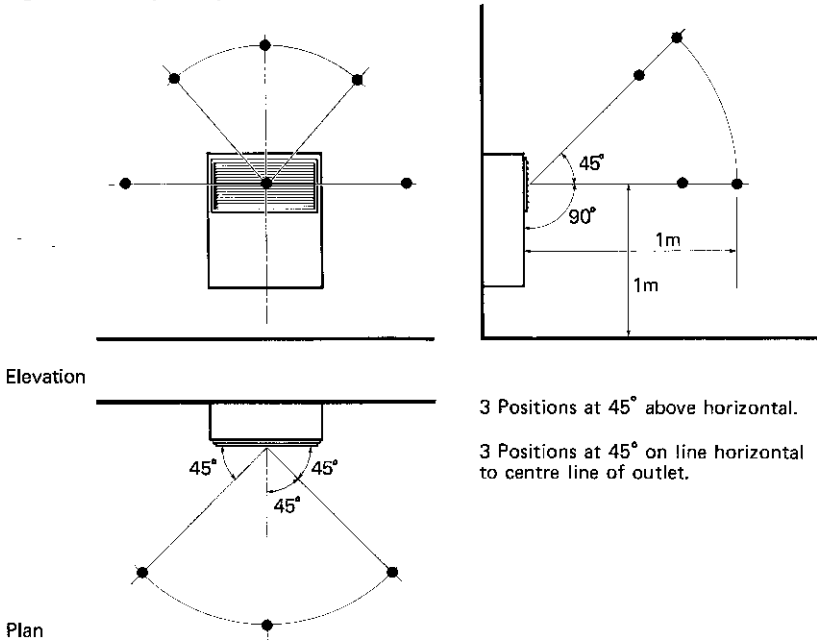
This must include:

- a) Size and model number of the test unit.
- b) Details of mounting arrangement.
- c) Mode of operation - intake, extract or recirculatory.
- d) Details of electrical supply - measured voltage and nominal frequency.
- e) What accessories were fitted (speed control, grilles, louvres, deflectors, backdraught shutters etc).
- f) The setting(s) at which the unit was tested and the corresponding octave band sound pressure levels over the range 63-8000 Hz, also the A-weighted broad-band sound pressure level at each measuring position.
- g) Background sound pressure levels in each octave band over the range 63-8000 Hz.

h) The real-room sound pressure level of the product for each setting tested shall be derived for each octave band, over the range 63-8000 Hz according to the averaging procedure of Section 8.1 of the main document.

i) The overall A-weighted sound pressure level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

Figure A1 Microphone positions



3 Positions at 45° above horizontal.

3 Positions at 45° on line horizontal to centre line of outlet.

APPENDIX B

POWERED WALL-MOUNTED VENTILATORS

B.1 SCOPE

This section is concerned with the measurement of noise produced by cased fan-powered ventilator units normally wall-mounted and supplying either fresh, tempered or recirculated air into the room space. Provision is also made for units which are fitted to extract air only from the room.

B.2 INSTALLATION AND OPERATION

B.2.1 Mounting Procedure

The unit under test shall be mounted on a 12.5 mm thick plywood panel on timber studding. The vertical studs shall be at not more than 600 mm centres with horizontal

cross bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel. The mounting height shall be one metre from the floor to the centre of the air discharge grille. Some units designed for extracting air frequently have the extract grille mounted horizontally in the base of the unit. In such cases the mounting height of one metre shall be to this reference plane.

B.2.2 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

B.2.3 Operation During Tests

The fans used in such units are generally powered by small shaded-pole motors whose speed often varies considerably with even minor variations in mains voltage, therefore this mains voltage should be measured.

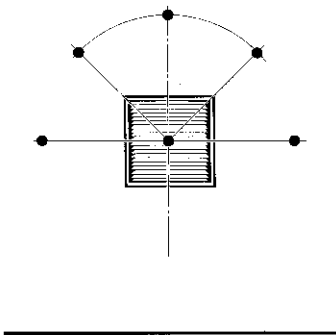
It is essential to start and run the unit for a minimum warm-up period of 30 minutes until steady-state running conditions are reached prior to commencing the tests.

B.2.4 General

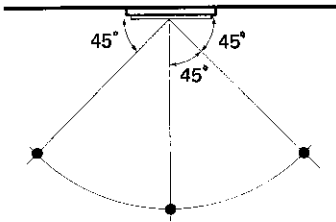
Any accessories which are normally part of the standard unit such as grilles and anti-backdraught shutters shall be fitted.

If the product is normally supplied with a speed control, then this shall be fitted and, in case of a stepped speed control, noise measurements carried out at each of the control settings and recorded separately. If an infinitely variable speed control is usually supplied noise measurements shall be made at full-speed and at three-quarter and half of the maximum speed, and the data recorded separately. Where a reversing facility is normally provided, then noise measurements shall be made with the fan operating in both the supply and the exhaust modes, and the data recorded separately.

Figure B1 Microphone positions



Elevation



Plan

B.3 NOISE MEASUREMENT

B.3.1 Location of Measurement Positions

Six microphone positions shall be used at one metre distance from the outlet air plane. Three positions shall be at 45° intervals in the horizontal plane and three positions at 45° intervals in the plane above the horizontal, as in Fig. B.1.

B.3.2 Measurements of Sound Pressure Level

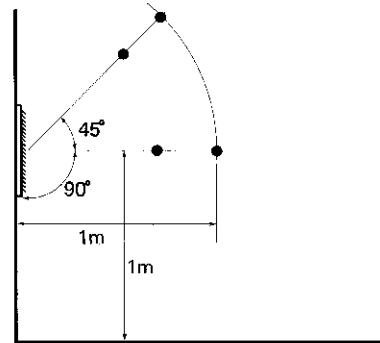
Sound pressure levels in each of the octave bands over the range 63-8000 Hz shall be recorded at each measuring position.

B.3.3 A-weighted Broad-band Sound Pressure Level

The A-weighted broad-band sound pressure level dBA, shall be recorded at each measuring position.

B.3.4 Background Noise Levels

Background levels in each octave band at each measuring position shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.



3 Positions at 45° above horizontal.

3 Positions at 45° on line horizontal to centre line of outlet.

B.4 INFORMATION TO BE PRESENTED

This must include:

- Size and model number of the test unit.
- Details of mounting arrangement.
- Mode of operation-intake, extract or recirculatory.
- Details of electrical supply - measured voltage and nominal frequency.
- What accessories were fitted (speed control, grilles, louvres, deflectors, backdraught shutters etc).
- The setting(s) at which the unit was tested and the corresponding octave band sound pressure levels

- over the range 63-8000 Hz, also the A-weighted broad-band sound pressure level at each measuring position.
- Background sound pressure levels in each octave band over the range 63-8000 Hz.
- The real-room sound pressure level of the product for each setting tested shall be derived for each octave band, over the range 63-8000 Hz, according to the averaging procedures of Section 8.1 of the main document.
- The overall A-weighted sound pressure level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX C

BATHROOM AND TOILET EXTRACT UNITS

C.1 SCOPE

This section is concerned with the measurement of noise produced by cased fan powered extract ventilators designed primarily for the mechanical ventilation of internal rooms, bathrooms and toilets. Provision is made for both surface mounted and flush mounted arrangements and simulating a wall or ceiling.

C.2 INSTALLATION AND OPERATION

C.2.1 Mounting Arrangement

C.2.1.1 Wall Mounting

The unit under test is to be mounted at half-height and 0.5 m to left or right from centre on a 12.5 mm thick plywood panel on timber studding as in Fig. C.1. The

vertical studs shall be at not more than 600 mm centres with horizontal cross bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel.

The unit should be fixed according to the manufacturer's instruction, using the isolating gasket if provided.

C.2.1.2 Ceiling Mounting

The unit under test is to be mounted 0.5 m from the centre of the ceiling along a diagonal as in Fig. C.1. The ceiling is to be similarly constructed to that described for the wall mounting in Section C.2.1.1.

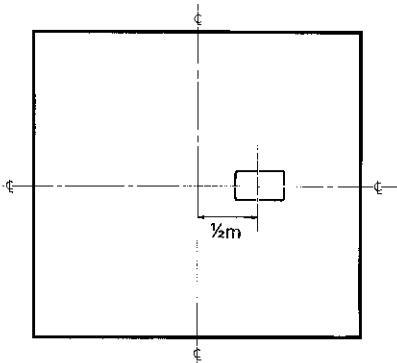
The unit should be fixed strictly according to the manufacturer's instructions, using the isolating gasket if provided.

C.2.2 Air Balance

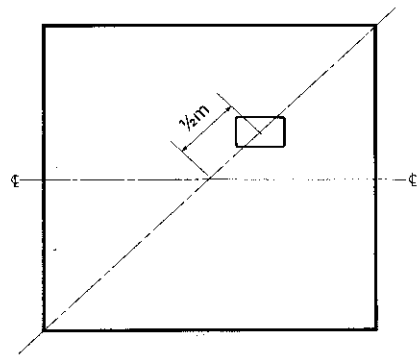
An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation.

Figure C1 Unit mounting position



Elevation of wall mounting position



Plan of ceiling mounted unit

The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

C.2.3 Operation During Tests

The fans used in such units are generally powered by small shaded pole motors whose speed often varies considerably with even minor variations in mains voltage therefore this mains voltage should be measured.

It is essential to start and run the unit for a minimum warm-up period of 30 minutes until steady-state running conditions are reached prior to commencing the tests.

C.2.4 General

Any accessories which are normally part of the standard unit such as grilles, anti-backdraught shutters shall be fitted. Some units may have a two speed selection facility and the sound level measurements shall then be taken at both speeds and recorded separately.

C.3 NOISE MEASUREMENT

C.3.1 Location of Measurement Positions

C.3.1.1 Wall-mounted unit

Nine measurement positions are to be used at 1 m distance from the front face of the unit. Three positions are to be at 45° intervals in the horizontal plane, three

positions at 45° intervals in the plane above the horizontal and three positions at 45° in the plane below the horizontal see Fig. C.2.

C.3.1.2 Ceiling-mounted units

Nine microphone positions are to be used at 1 m distance from the front face of the unit. Three positions are to be at 45° intervals in the vertical plane down from the unit such that the central position is directly below the front face. Three positions are to be in a plane at 45° rotated up from this vertical plane in a clockwise direction in corresponding rotated locations. Three positions are to be in a plane at 45° rotated up from this vertical plane in an anti-clockwise direction - Fig. C.2.

C.3.2 Measurements of Sound Pressure Level

Sound pressure levels in the octave bands over the range 63-8000 Hz shall be recorded at each measuring position.

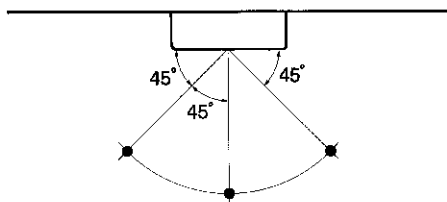
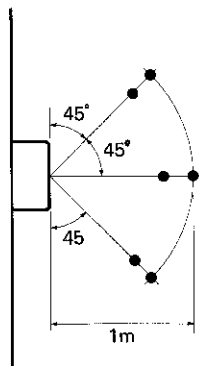
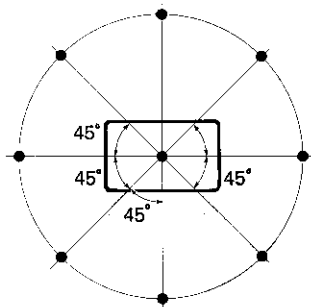
C.3.3 A-weighted Broad-band Sound Pressure Level

The A-weighted sound pressure level dBA, shall be recorded at each measuring position.

C.3.4 Background Noise Levels

Background levels in each octave band at each measuring position shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

Figure C2 Microphone positions



Wall Mounted Unit

3 Positions at 45° above horizontal

3 Positions on plane horizontal to centre of unit

3 Positions at 45° below horizontal

Ceiling Mounted Unit

3 Positions at 45° left of vertical

3 Positions right of vertical

3 Positions at 45° on the vertical plane

C.4 INFORMATION TO BE PRESENTED

This must include:

- Type, size and model number of the test unit.
- Details of mounting arrangement (surface or flush mounted, wall- or ceiling-mounted).
- Details of electrical supply, voltage and frequency.
- What accessories were fitted (grilles, anti-backdraught shutters etc.).
- The setting(s) at which the unit was tested and, at each measuring position, the corresponding octave band sound pressure levels over the range 63-8000 Hz and the A-weighted broad-band sound pressure level.
- Background sound pressure levels in each octave band over the range 63-8000 Hz.
- The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz, according to the averaging procedure of Section 8.1 of the main document.
- The overall A-weighted sound pressure level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX D

DUCTED FLOWRATE CONTROL DEVICES

D.1 SCOPE

This section is concerned with the measurement of noise generated by ducted flowrate control devices used in a supply or extract mode. Typically this is intended to cover: dampers, constant flowrate single or dual duct devices, variable flowrate single or dual duct devices.

Some units may also incorporate or have reheat coils and/or secondary silencers. These items can also influence noise generation and should be included in the test programme. However it is not necessary to provide electrical power or water for coils as it is physical presence in the air stream which is important.

Procedures are given to evaluate;

For supply air application (see Fig. D.1a)

- Downstream (low pressure side) duct outlet noise.
- Casing radiated noise.
- Upstream duct breakout noise.

For extract air application (see Fig. D.1b)

- Upstream (low pressure side) ducted inlet noise.
- Casing radiated noise.
- Downstream duct breakout noise.

Figure D1a Supply Air Device Assembly

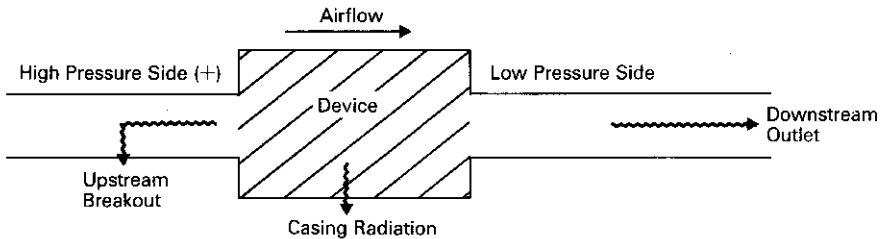
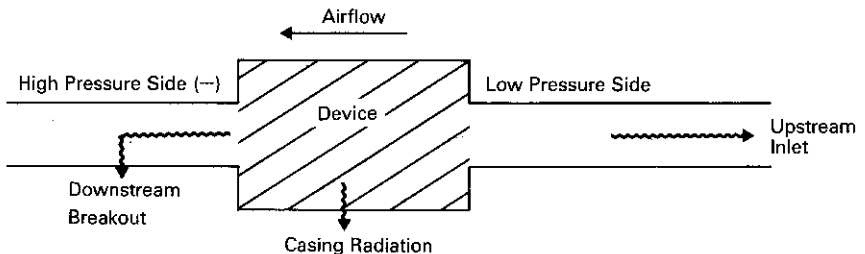


Figure D1b Extract Air Device Assembly



D.2 INSTALLATION

D.2.1 Supply/extract device low pressure outlet/inlet noise level

Equipment is normally located above the ceiling, under the floor, or in another space adjacent to the room being served. For the purpose of this test the equipment including any secondary silencers and/or coils shall be installed outside the test room and connected to the test room by an unlined duct 1 metre long of the same shape and cross sectional area as the equipment outlet/inlet connection. The duct shall terminate flush with any surface and away from any possible room symmetry as shown in Fig. D.2.

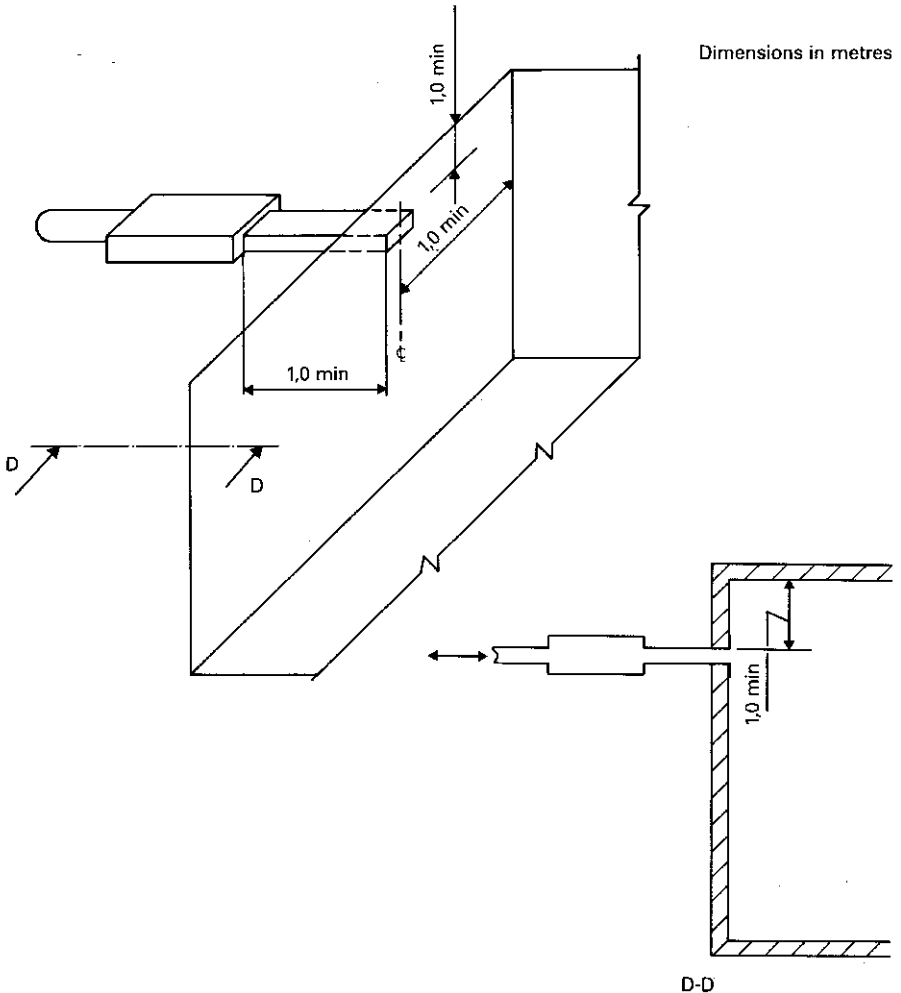


Figure D2 Mounting position for device installed outside room boundary

D.2.2 Supply/extract device casing radiated noise level

For the purpose of this test the equipment including any secondary silencer and/or coils shall be mounted in the test room with suitably acoustically insulated test ducts. For clarification of suitable insulation, see section D.2.6. The assembly shall be installed within the size limits as shown in Fig. D.3.

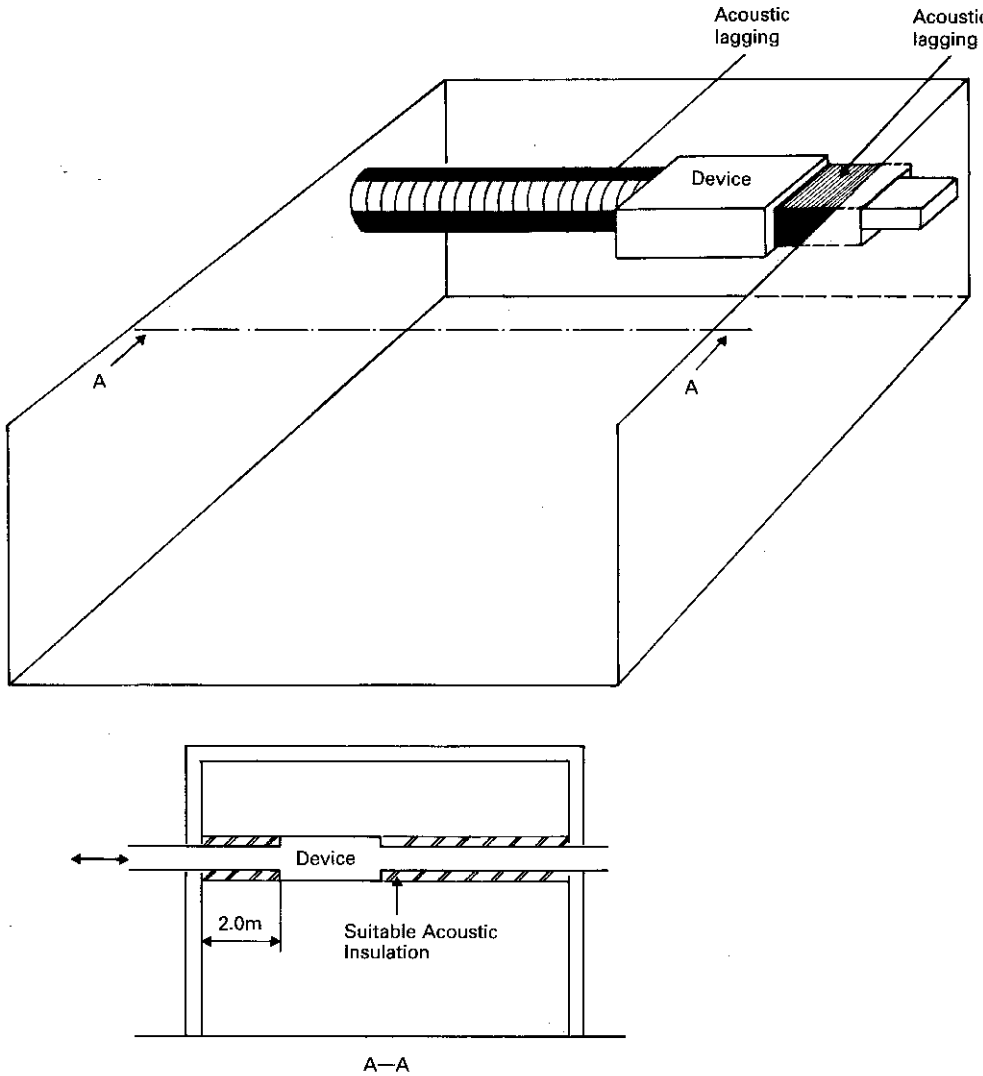


Figure D3 Mounting position for device to determine casing radiated noise

D.2.3 Supply/extract high pressure duct breakout noise level

Test room configuration shall be as in D.2.2 except insulation shall be omitted from the duct where noise breakout is to be measured. Additionally suitable acoustic insulation shall be added to the assembly to control casing breakout noise. For clarification of suitable insulation see section D.2.6. See Fig. D.4 for layout details.

D.2.4 Dual duct supply devices

In the case of this type of device both hot and cold supply ducts should be connected to the air supply. The blending valve should be cycled a number of times and then closed on either the hot or cold duct for the test programme.

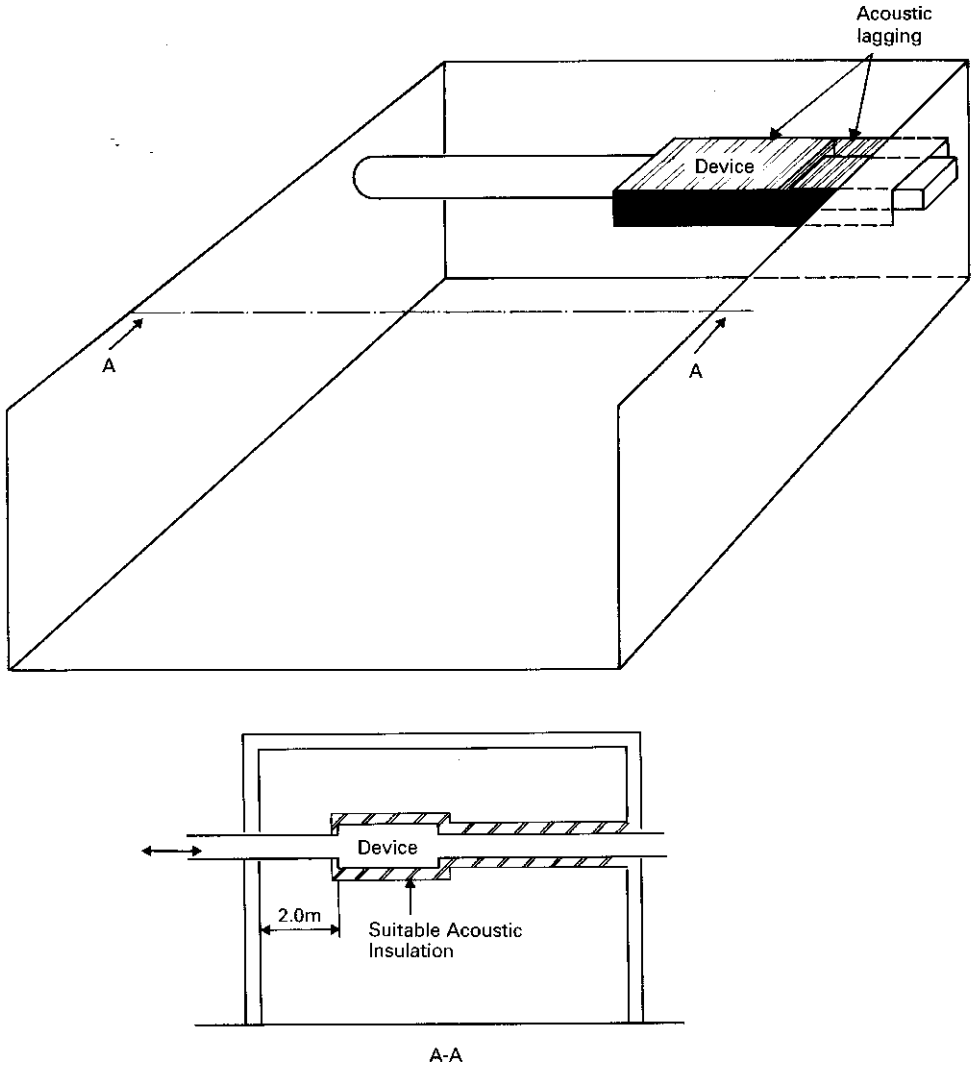


Figure D4 Mounting position for device to determine high pressure side duct breakout noise

D.2.5 Air supply noise check silencer

The noise check silencer is employed to ensure that the quiet air supply is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on removal of this silencer the measured noise level for any operating condition/test configuration does not increase by greater than 1 dB in each octave band under investigation. The test shall be carried out with the noise check attenuator in place to ensure that the air supply is sufficiently silenced for the tolerance required of this test technique.

D.2.6 Suitable acoustic insulation

The function of this is similar to that of the noise check silencer, namely to ensure that noise radiating from the insulated areas is not contributing to sources of radiated noise being measured. Lagging should be progressively applied to areas requiring treatment until the measured noise level reduction in each octave band under investigation for any operating condition is 1 dB or less. For guidance it is suggested that the lagging material is added in layers which are at least 5 kg/m² surface density, care being taken to ensure continuity and adequate sealing around the object to be insulated thus ensuring maximum noise reduction is achieved. The tests shall then be carried out with this final standard lagging fitted to ensure that only the relevant breakout noise level is being measured.

D.3 OPERATION

Tests shall be carried out on the assemblies at a series of pressure drops across the device and a range of air volume flowrates to establish the variation of noise level with both parameters.

As a minimum, information shall be established for the following:

- Maximum Air Flow at Maximum Pressure Drop
- Maximum Air Flow at Minimum Pressure Drop
- Minimum Air Flow at Maximum Pressure Drop
- Minimum Air Flow at Minimum Pressure Drop

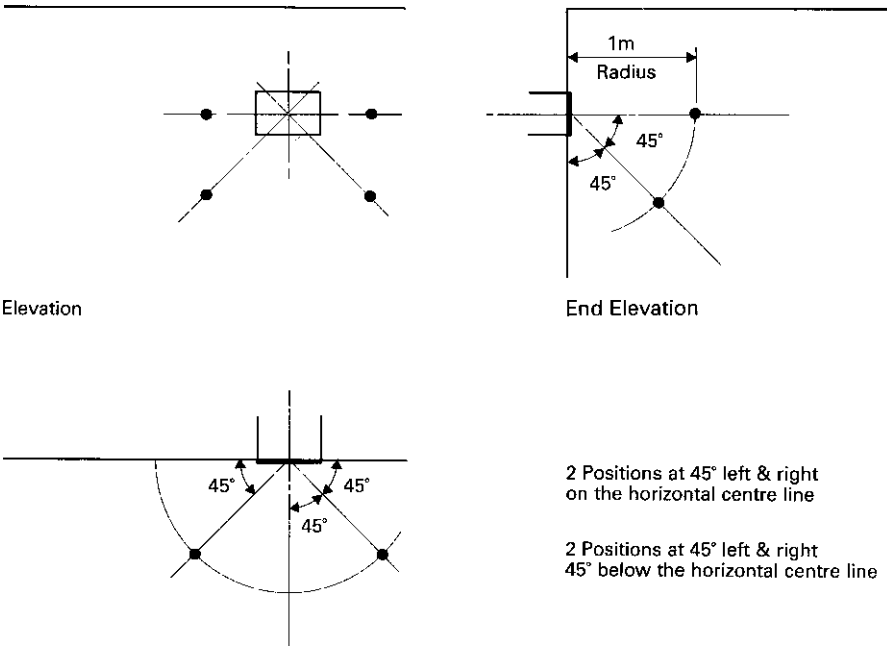
D.4 NOISE MEASUREMENT

D.4.1 Location of measurement positions

D.4.1.1 Supply/extract device low pressure outlet/inlet noise level

Four microphone positions shall be used at 1m radius from the air outlet/inlet plane. Two positions shall be in a horizontal plane spaced at 45° to left and right of the centreline. A further two positions shall be at the same location but in a plane at 45° to horizontal, see Fig. D.5.

Figure D5 Microphone positions for outlet/inlet noise



Elevation

End Elevation

Plan

2 Positions at 45° left & right on the horizontal centre line

2 Positions at 45° left & right 45° below the horizontal centre line

D.4.1.2 Supply/extract device casing radiated noise level

Three microphone positions shall be used at 1m radius from the centre of the under surface of the device. One position directly beneath the box and two at 45°, see Fig. D.6.

D.4.1.3 Supply/extract high pressure duct breakout noise level

As in D.4.1.2 except the array is positioned in the centre of the unlagged duct.

D.4.2 Measurements of sound pressure level

Sound pressure levels in each of the octave bands over the range of 63-8000 Hz shall be recorded at each measurement position.

D.4.3 A-Weighted broad band sound pressure level

The broad band A-weighted sound pressure level in dBA shall be recorded at each measurement position.

D.4.4 Background noise level

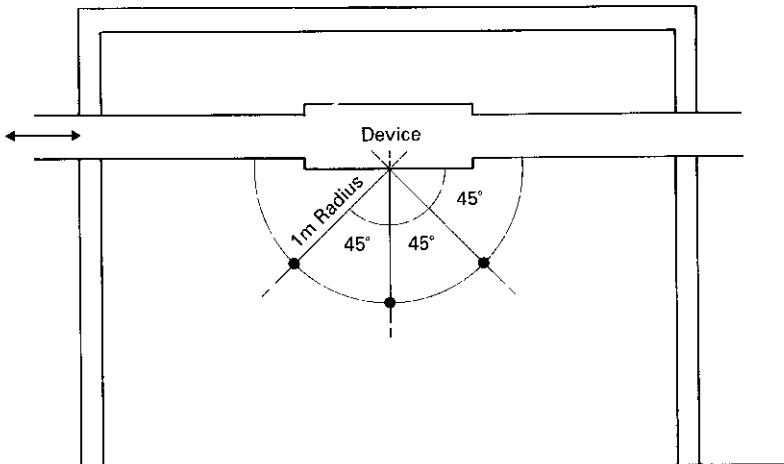
Background noise levels in each octave band at each measuring position shall be recorded before and after each test series to demonstrate that extraneous noises have been excluded from the measurement and that the necessary 6 dB separation has been achieved.

D.5 INFORMATION TO BE PRESENTED

This shall include:

- Type, size and model of the test unit, including ancillaries, and also the name of the manufacturer.
- Details of the mounting arrangement and the unit's position within the room, where appropriate.
- Air volume flow and associated pressure drop across the device.
- Background sound pressure levels in each octave band over the range 63-8000 Hz for the configuration tested.
- The real room sound pressure level of the device for each setting and configuration tested shall be derived for each octave band, over the range 63-8000 Hz according to the averaging procedure of section 8.1 of the main document.
- The overall A-weighted level of the product for each setting and configuration tested shall be derived according to the averaging procedure of section 8.2 of the main document.

Figure D6 Microphone positions for casing radiated noise



One position directly beneath the device

Two position at 45° parallel to the centre line of the device

APPENDIX E

AIR TERMINAL DEVICES

E.1 SCOPE

This section is concerned with the measurement of noise produced by Air Terminal Devices connected to air duct systems or unitary equipment.

Figure E1 Diffuser connections

E.2 INSTALLATION AND OPERATION

E.2.1 Installation

The Air Terminal Device shall be installed in accordance with good practice and with duct connections typically as shown in Figs. E1-E3. These figures correspond to Figs. 5.1-5.3 respectively of the HEVAC Air Diffusion Guide (2/02/82), A Guide to Good Practice. It is recommended that the tester obtain a copy of this guide and use it to assist him in the application of the device to be tested in this section.

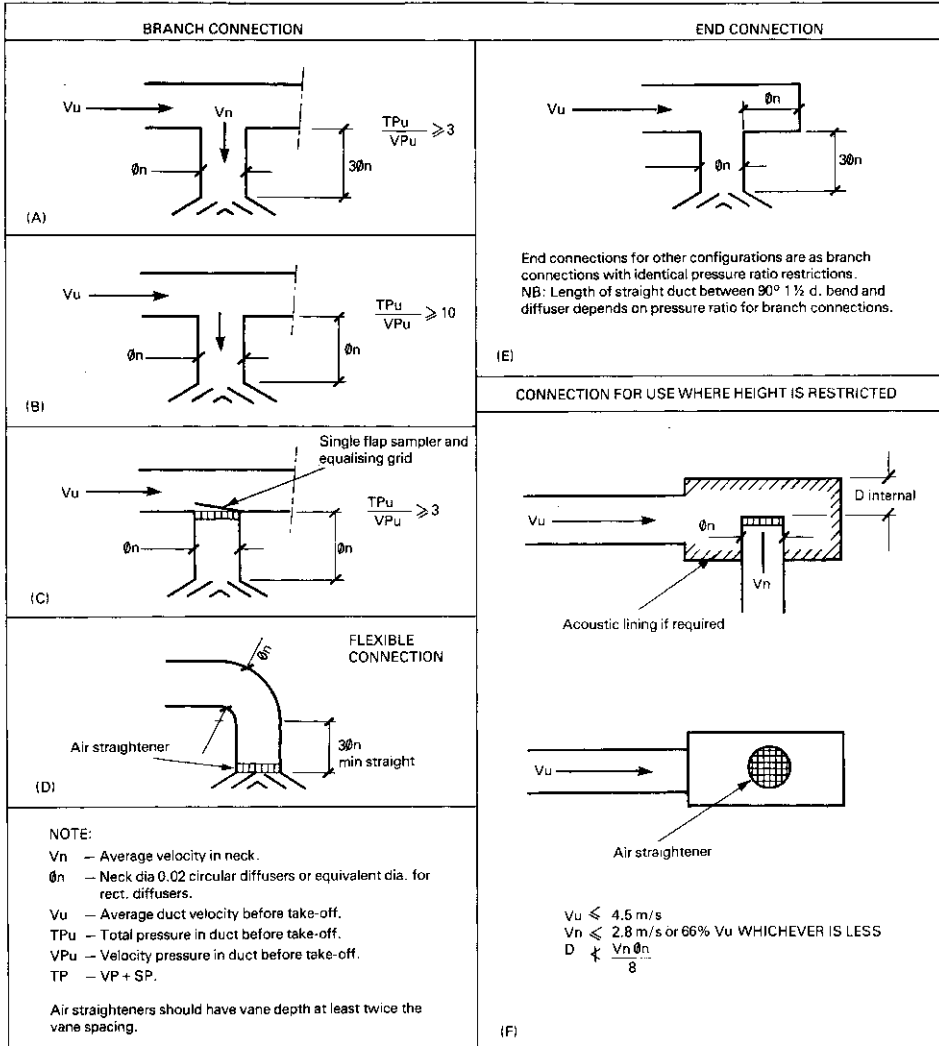


Figure E2 Grille connections

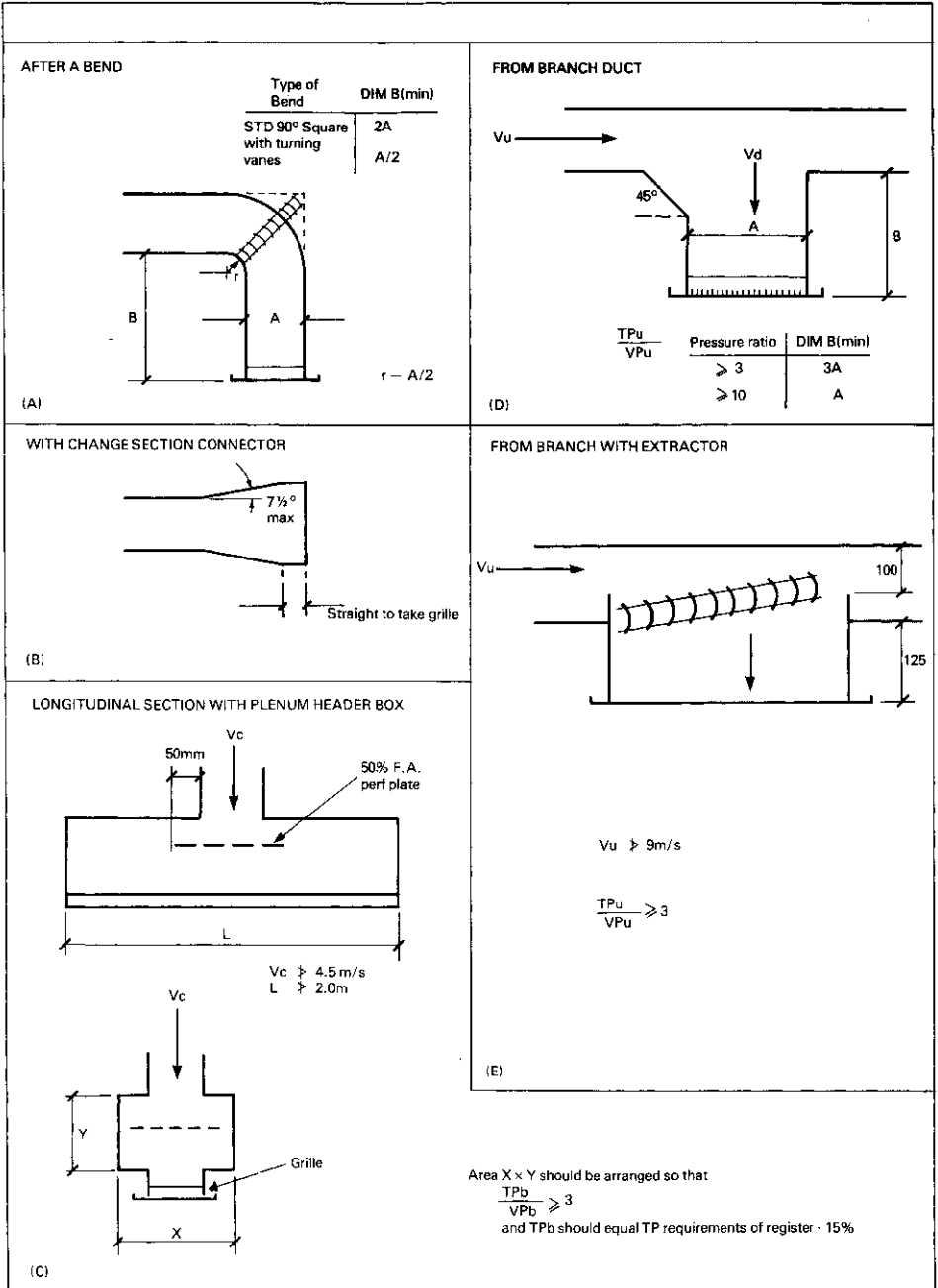
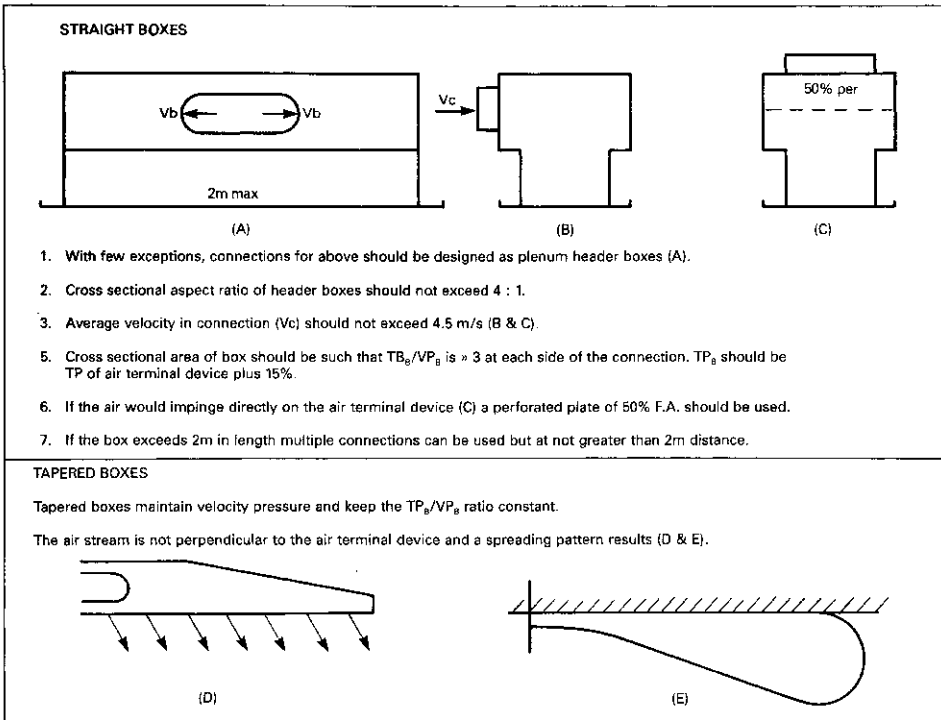


Figure E3 Linear grille/diffuser connection



All ancillary equipment necessary in the normal use of the device shall be fitted. This may include such things as stub ducts, plenum boxes, control dampers, air flow straighteners etc.

Fig. E4 shows the requirements for the location of the Air Terminal Device within the test room, and these requirements are shown for the various intended applications which this group of devices may have.

E.2.2 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests shall be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

E.2.3 Operation During Tests

Prior to the installation of the Air Terminal Device, preliminary tests should be carried out as if the device were already fitted in its chosen test position in order to establish the noise levels present in the test room from the provisioning system (which system includes the air-balance arrangements) with the air flow(s) required. In some installations a silencer may be necessary.

Tests shall be carried out on the installed device at a series of air volume flow rates according to the type of device under test.

Supply Air Terminal Devices with adjustable blades shall be tested with the blades set at the required deflection. Air Terminal Devices with control dampers shall be tested at a range of damper settings to cover practical applications.

E.2.4 Noise Check Attenuator

The noise check attenuator is employed to ensure that the quiet air supply is, indeed, sufficiently quiet for each of the tests carried out and it must be established that on removal of this attenuator the measured noise level for any operating condition does not increase by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with this noise check attenuator in place to ensure that the air supply is sufficiently attenuated for the tolerance required of this test technique.

E.3 NOISE MEASUREMENT

E.3.1 Location of Measurement Positions

Recommended locations for each air terminal location are given in Fig. E.4 while the microphone positions are to be as given in Table E1. See other appendices for typical arrangements.

Figure E4 Permissible mounting positions

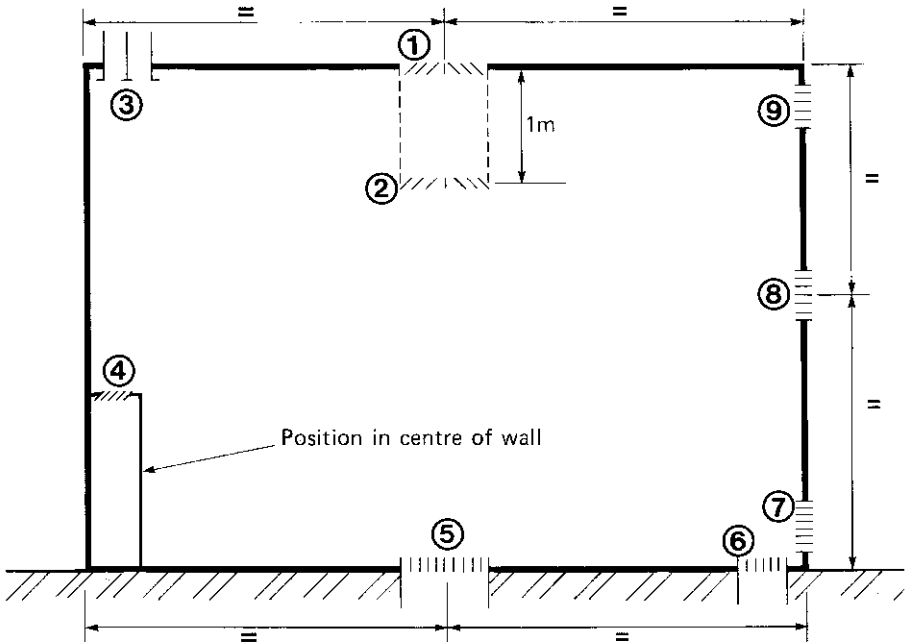


Table E1 Location and number of microphone positions

No	ATD POSITIONS		MICROPHONE POSITIONS	
	Description	Radius m	Number of measuring locations	Location at one pitch
1	a Diffuser – finite flush	1	5	1 beneath 4 @ 45°
	b Diffuser – linear flush	1	3x3 pitches	1 beneath 2 @ 45°
2	Diffuser finite in space	1	5	1 beneath 4 @ 45°
3	Diffuser linear corner ceiling /wall	1½	1 x 3 pitches	1 @ 45°
4	a Sill grille finite	1	4	1 @ 90° 3 @ 45° to vert
	b Sill grille linear	1	2 x 3 pitches	1 @ 90° 1 @ 45° to vert
5	Floor grille linear centre	1	3 x 3 pitches	1 above 2 @ 45°
6	Floor grille linear corner floor/wall	1½	1 x 3 pitches	1 @ 45°
7	Grille finite corner floor/wall	1½	3	3 @ 45°
8	Grille finite wall	1	5	1 beneath 4 @ 45°
9	Grille linear wall corner wall/ceiling	1½	1 x 3 pitches	1 @ 45°

E.3.2 Measurements of Sound Pressure Level

Sound pressure levels in each octave band over the range 63 - 8000Hz, also the A-weighted broad-band sound pressure level dBA, shall be recorded at each measuring position. In order to establish acceptable background noise levels the following procedure should be adopted:

- a) Fit air terminal device.
- b) Set up the minimum air flow proposed for testing.
- c) Measure noise level in each octave band at each measuring position.
- d) Remove air terminal device and its ancillary equipment.
- e) Reset air flow to minimum value selected.
- f) Remeasure noise level.

Removal of the air terminal device should result in a noise level reduction of at least 6dB in each octave band. Nevertheless, if three or less octave bands are affected and these are at least 6dB below the highest octave band level for the terminal, then the results may be reported and the ambient noise contaminated octave band levels identified.

If the above criteria cannot be met then investigate means of reducing the background noise.

E.4 INFORMATION TO BE PRESENTED

These shall include:

- a) Size and model number of the unit tested.
- b) Details of mounting arrangement and the unit's position in the room.
- c) Mode of operation - supply, extract or recirculatory.
- d) Details of electrical supply used for the unit on test - measured voltage and nominal frequency.
- e) Details of ancillaries fitted (stub ducts, plenum boxes, control dampers, air flow straighteners etc.).
- f) The setting(s) at which the unit was tested, the corresponding sound pressure levels in each octave band over the range 63 - 8000 Hz, also the A-weighted broad-band sound pressure level, at each measuring position.
- g) Background sound pressure levels in each octave band over the range 63 - 8000 Hz. This background should be that obtained with the provisioning system providing the air flow(s) required, with any necessary attenuator, as set out in Section E.2.1, but without the Air Terminal Device. The background levels with the unit installed but without air flow shall also be reported.
- h) For each setting tested, the real-room sound pressure level of the product shall be derived for each octave band, also the overall A-weighted level, according to the averaging procedures of Section 8.1 & 8.2 of the main document respectively.

APPENDIX F

FAN CONVECTORS

F.1 SCOPE

This appendix is concerned with the measurement of noise produced by fan convectors. A fan convector is a compact unit consisting of a fan or fans, filter, and heating coil or electric element.

The fan is generally of centrifugal or tangential type and on larger units may be mounted as multiples in parallel. Most fans are fitted with direct drive electric motors.

Any accessories which are normally part of the standard unit such as grilles, discharge spigots, etc. must be specifically highlighted and reported when included in the test arrangement.

F.2 INSTALLATION AND OPERATION

F.2.1 Mounting Procedure:

The unit under test is to be mounted on a 12.5 mm thick plywood panel on timber studding. The vertical studs shall be at not more than 600 mm centres with horizontal cross bracing between studs of maximum 800 mm centres to ensure adequate stiffness of the plywood panel. The mounting position is to be as specified by the manufacturer or, if not specified, at a height of 1 m above floor level to the air discharge grille axis.

The unit shall be mounted against the test wall in such a way that the unit's geometric centre is 0.5 m from the centre of this wall's width. See Fig. F.1.

F.2.2 Operation during tests.

The fans used in such units are generally powered by small shaded-pole motors whose speed often varies considerably with even minor variations in mains voltage. This mains voltage should be measured.

It is essential to start and run the unit for a minimum warm-up period of 30 minutes until steady-state running conditions are reached, prior to commencing the tests.

F.2.3 General

Any accessories which are normally part of the standard unit such as grilles and filters shall be fitted.

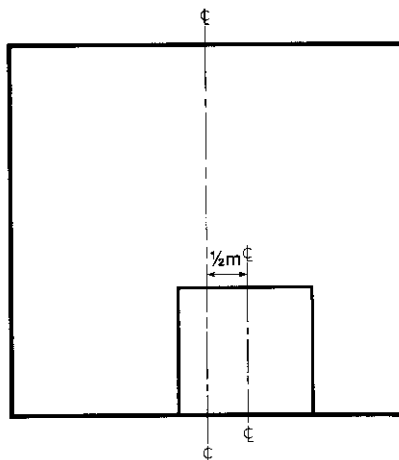
If the product is normally supplied with a speed control, then this shall be fitted and, in the case of a stepped speed controller, noise measurements carried out at each of the control settings and recorded separately. If an infinitely variable speed control is usually supplied, noise measurements shall be made at full speed and at three-quarter and half of the maximum speed, and the data recorded separately.

F.3 NOISE MEASUREMENT

F.3.1 Location of Measurement Positions

Six microphone positions are to be used at 1 m distance from the outlet-air plane. Three of these positions are to be at 45° intervals in the horizontal plane, the centre position being directly in front of the vertical centre line of the unit and the remaining three locations will also be

Figure F1 Unit Mounting Positions



Elevation of wall mounted unit

at 45° intervals but in a plane up 45° from the horizontal with again the central position in front of the outlet, as in Fig. F.2.

F.3.2 Measurements of Sound Pressure Level

Sound pressure levels in each octave band over the range of 63-8000 Hz. shall be recorded at each measuring position.

F.3.3 A-weighted Broad-band Sound Pressure Level

A-weighted sound pressure level dBA shall be recorded at each measuring position.

F.3.4 Background Noise Levels

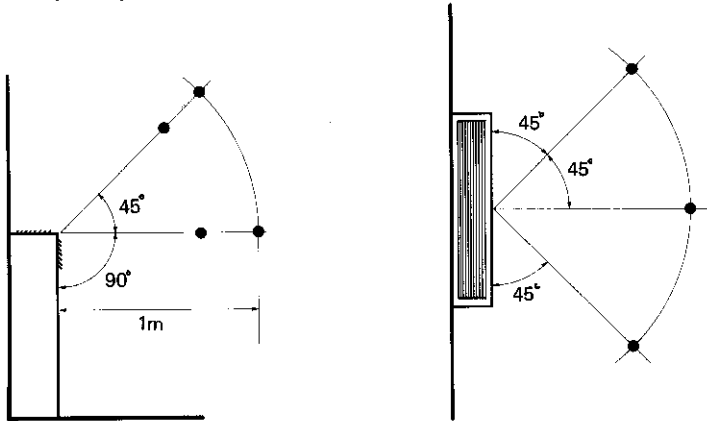
Background levels in each octave band at each measuring position shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

F.4 INFORMATION TO BE PRESENTED

This must include:

- Type, size and model number of the test unit and manufacturer's name.
- Details of mounting arrangement.
- Mode of operation.
- Details of electrical supply - measured voltage and nominal frequency.
- What accessories were fitted (speed control, grilles, louvres, deflectors etc.).

Figure F2 Microphone positions



3 Positions at 45° intervals the central one being directly in front of the outlet.

3 Positions at 45° to the horizontal plane in corresponding locations.

- f) The setting(s) at which the unit was tested and, at each measuring position, the corresponding octave band sound pressure levels over the range 63-8000 Hz, and the A-weighted broad-band sound pressure level.
- g) Background sound pressure levels in each octave band over the range 63-8000 Hz.
- h) The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz according to the averaging procedure of Section 8.1 of the main document.
- i) The overall A-weighted level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX G

FAN COIL UNITS

G.1 SCOPE

This appendix is concerned with the measurement of noise produced by fan coil units. Provision is also made for units which are:

- a) fully recirculating room air.
- b) partly recirculating room air and partly fresh air.

A fan coil unit is a compact unit consisting of a fan or fans, filter, and heating/cooling coils. Fan coil units fitted with refrigerant direct expansion coils are covered by Appendix J (Split systems).

The fan is generally of centrifugal or tangential type and on larger units may be mounted as multiples in parallel. Most fans are fitted with direct drive electric motors.

Any accessories which are normally part of the standard unit such as grilles, discharge spigots, fresh air connections etc. must be specifically highlighted and reported when included in the test arrangement.

G.2 INSTALLATION AND OPERATION

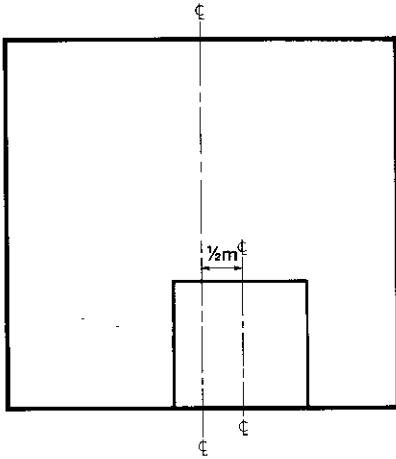
G.2.1 Mounting Procedure:

G.2.1.1 Wall-mounted units

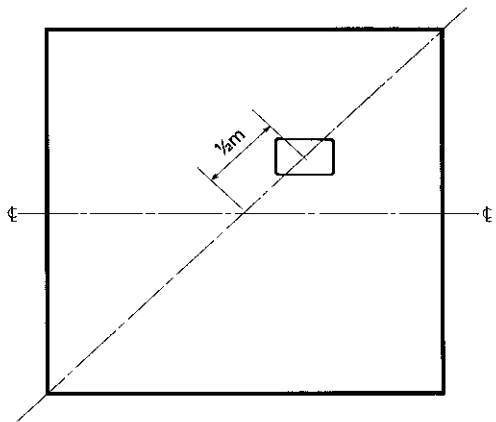
The unit under test is to be mounted on a 12.5 mm thick plywood panel on timber studding. The vertical studs shall be at not more than 600 mm centres with horizontal cross bracing between studs of maximum 800 mm centres to ensure adequate stiffness of the plywood panel. The mounting position is to be as specified by the manufacturer or, if not, specified, at a height of 1 m above floor level to the air discharge grille axis.

The unit shall be mounted against the test wall in such a way that the unit's geometric centre is 0.5 m from the centre of this wall's width. See Fig. G.1.

Figure G1 Unit Mounting Positions



Elevation of wall mounting position



Plan of ceiling mounted unit

G.2.1.2 Ceiling-mounted units.

The unit under test is to be mounted on a 12.5 mm thick plywood panel on timber studding. The longitudinal studs shall be at not more than 600 mm centres with horizontal cross-bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel.

The unit shall be mounted with its geometric centre 0.5 m diagonally from the vertical axis of the test room. See Fig. G.1.

If required, a false ceiling may be installed below the unit, constructed from mineral fibre tiles in an exposed T-bar grid. The mineral fibre tiles shall have a weight not exceeding 5 kg/m².

Where a false ceiling is installed below a test unit the ceiling must cover the full extent of the test room, and have all necessary apertures for supply and recirculation air to enable the unit to operate correctly.

G.2.1.3 Air balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125 - 8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

G.2.1.4 Operation during tests.

The fans used in such units are generally powered by small shaded-pole motors whose speed often varies considerably with even minor variations in mains voltage, therefore this mains voltage should be measured.

It is essential to start and run the unit for a minimum warm-up period of 30 minutes until steady-state running conditions are reached prior to commencing the tests.

G.2.1.5 General

Any accessories which are normally part of the standard unit such as grilles and filters shall be fitted.

If the product is normally supplied with a speed control, then this shall be fitted and, in the case of a stepped speed controller, noise measurements carried out at each of the control settings and recorded separately. If an infinitely variable speed control is usually supplied, noise measurements shall be made at full speed and at three-quarter and half of the maximum speed, and the data recorded separately.

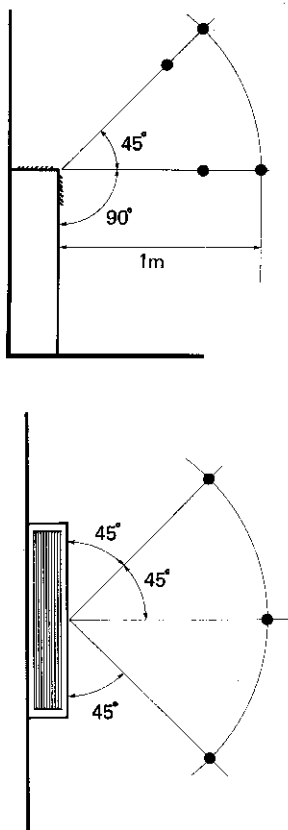
G.3 NOISE MEASUREMENT

G.3.1 Location of Measurement Positions

G.3.1.1 Wall-mounted unit

Six microphone positions are to be used at 1 m distance from the outlet-air plane. Three of these positions are to be at 45° intervals in the horizontal plane, the centre position being directly in front of the vertical centre line of the unit and the remaining three locations will also be at 45° intervals but in a plane up 45° from the horizontal with again the central position in front of the outlet, as in Fig. G.2.

Figure G2 Microphone positions for wall mounted unit



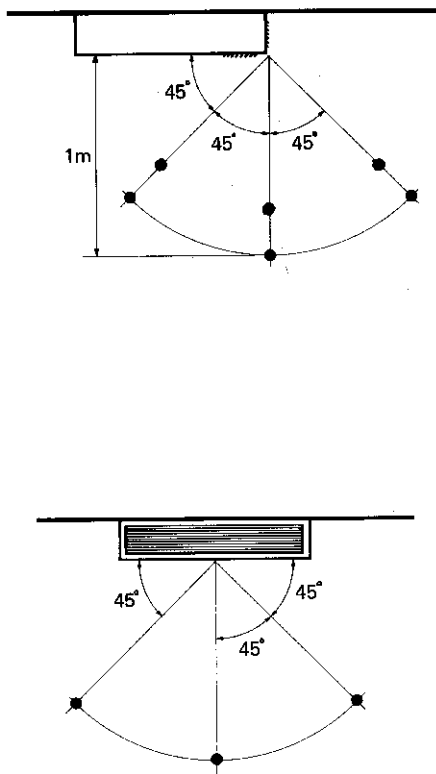
3 Positions at 45° intervals the central one being directly in front of the outlet.

3 Positions at 45° to the horizontal plane in corresponding locations.

G.3.1.2 Ceiling-mounted units

Nine microphone positions are to be used at 1 m distance from the outlet-air plane. Three positions are to be at 45° intervals in the vertical plane down from the unit such that the central position is directly below the outlet. Three positions are to be in a plane at 45° rotated up from this vertical plane in a clockwise direction in corresponding rotated locations. Three positions are to be in a plane at 45° rotated up from this vertical plane in an anti-clockwise direction - Fig. G.3.

Figure G3 Microphone positions for ceiling mounted unit



3 Positions in vertical plane at 45° intervals one being directly below outlet.

3 Positions in each plane at 45° to the vertical plane in corresponding rotated locations.

G.3.2 Measurements of Sound Pressure Level

Sound pressure levels in each octave band over the range of 63-8000 Hz. shall be recorded at each measuring position.

G.3.3 A-weighted Broad-band Sound Pressure Level

A-weighted sound pressure level dBA shall be recorded at each measuring position.

G.3.4 Background Noise Levels

Background levels in each octave band at each measuring position shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

G.4 INFORMATION TO BE PRESENTED

This must include:

- Type, size and model number of the test unit and manufacturer's name.
- Details of mounting arrangement.
- Mode of operation - intake, extract, fully recirculatory or partly recirculatory.
- Details of electrical supply - measured voltage and nominal frequency.

- What accessories were fitted (speed control, grilles, louvres, deflectors ect.).
- The setting(s) at which the unit was tested, the corresponding sound pressure levels in each octave band over the range 63-8000 Hz also the A-weighted broad-band sound pressure level, at each measuring position.
- Background sound pressure levels in each octave band over the range 63-8000 Hz.
- The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz according to the averaging procedure of Section 8.1 of the main document.
- The overall A-weighted level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX H

INDUCTION UNITS

H.1 SCOPE

This appendix is concerned with the measurement of the noise produced by wall and ceiling void mounted induction units. Provision is made for the acoustic testing of:

- Single units in which 100 per cent of the primary air is also discharged from the unit.
- Single units in which only a portion of the primary air is discharged from the unit, the remainder passing through a plenum box and away — Fig. H.2 — which usually form part of a chain of units in series.

The units may contain primary air dampers, when a series of duties will be measured. Various air mixing and diversion dampers may be included, requiring that specific test configurations are specified and monitored. Various nozzle combinations may also be tested.

Any decorative casing which may be introduced for architectural reasons must be specifically highlighted and reported when included in the test arrangement.

The test method does not require the connection of water to the coils.

H.2 INSTALLATION

H.2.1 Installation — Wall-mounted Single Unit

The unit shall be installed on the floor against the test wall such that the unit's centre is 0.5 m from the centre of this wall's width. See Fig. H.1. Monitored air must be supplied from a quiet air supply through a noise check attenuator and ten hydraulic diameters of matching straight ductwork. The noise check attenuator must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

No specific insertion loss is quoted for 63 Hz.

H.2.2 Installation - Wall-mounted Units In Series

The unit shall be installed on the floor against the test wall such that the unit's geometric centre is 0.5 m from the centre of this wall's width, see Fig. H.1. Monitored air will be supplied from a quiet air supply through a noise check attenuator and ten hydraulic diameters of matching straight ductwork. The noise check attenuator must have at least 5 dB static insertion loss in each of the octave bands from 125-8000 Hz. The outlet from the exhaust side should discharge into a noise check attenuator of similar specification to that on the inlet, see Fig. H.2. This should exhaust to an attenuated damping throttle allowing the exhaust air to be controlled without the noise generation from such a throttle being able to feed back into the unit and affect the results.

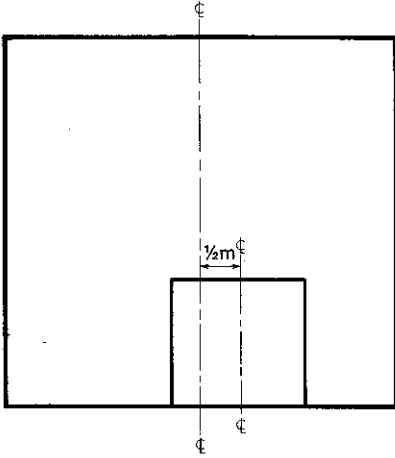
H.2.3 Installation - Ceiling-mounted Single Unit, Corner Located

The unit shall be installed on the ceiling into the corner formed by the ceiling and the test wall such that the unit's geometric centre is 0.5 m from the centre of this wall's width, see Fig. H.1. Monitored air will be supplied from a quiet air supply through a noise check attenuator and ten hydraulic diameters of matching straight ductwork. The noise check attenuator must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

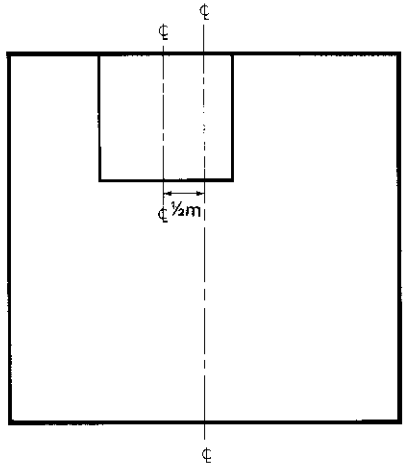
H.2.4 Installation - Ceiling-mounted Single Unit, Not Located in a Corner

The unit shall be installed on the main free area of the ceiling such that the unit's geometric centre is 0.5 m diagonally from the geometric centre of the ceiling, see Fig. H.1. This will still have some flexibility of location, which should be used to ensure that the inlet and outlet grilles are as far away from the test room walls as feasible. Monitored air will be supplied from a quiet air supply through a noise check attenuator and ten hydraulic diameters matching straight ductwork. The noise check attenuator must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

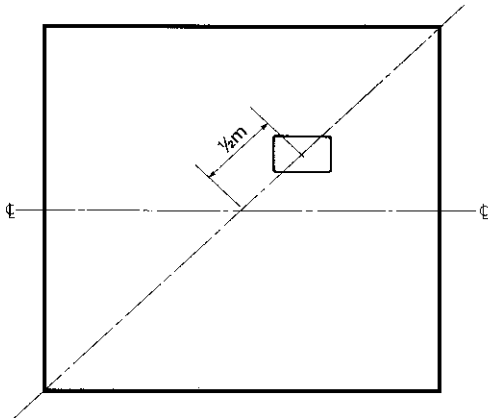
Figure H1 Unit Mounting Positions



Elevation of wall mounting position

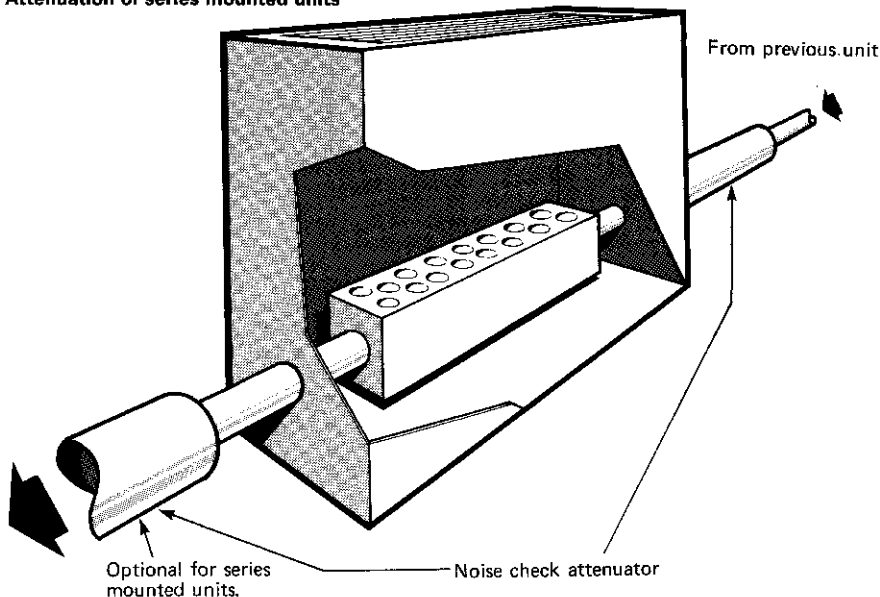


Plan of ceiling mounting position (corner mounted unit)



Plan of ceiling mounting position

Figure H2 Attenuation of series mounted units



H.2.6 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

H.3 OPERATION

Induction units are supplied with primary air, which by the action of discharging this primary air through nozzles or other constrictions, entrains secondary air from the conditioned space. This entrained air may pass through heating and/or cooling coils and modulation between such conditions may be incorporated. Additionally, a primary air control damper may be incorporated.

To achieve various induction ratios between the secondary and the primary air supply, a range of nozzles is available.

Hence, several variables, by combination, are permitted and the operation of the unit under test must be recorded taking cognisance of;

- primary air supply rate,
- primary air damper duty or setting,
- nozzle pressure,
- nozzle arrangement/code and
- secondary air damper settings.

The secondary induced air flow is not measured directly in these tests, but is monitored by the nozzle pressure reading, which can be related to the secondary air flow via calibration graphs from an independent aerodynamic test procedure.

H.3.1 Operation During Test Wall-mounted Single Unit

A particular nozzle arrangement will have been chosen for a group of tests. If present, any secondary air dampers will be preset.

Set the primary air damper fully open and supply a set of primary air volume flowrates commensurate with the unit's range. At each primary air volume flowrate the noise measurements shall be made as set out in Section H.4.1.1. together with the nozzle static pressure and the upstream primary air supply static pressure $1\frac{1}{2}$ diameters from the unit's inlet spigot.

Other additional primary air damper settings may be employed to generate additional upstream back pressure.

Alternative secondary air damper settings may be employed and also other nozzle arrangements tested. A set of measurements shall be recorded for each of these variables in combination:

- a) primary air damper setting,
- b) secondary air damper settings, and
- c) nozzle arrangement.

H.3.2 Operation — Wall-mounted Units in Series

For many applications induction units are placed in series and the primary air passes through a plenum at the base of each unit — Fig. H.2. It is possible for this application that the plenum box of the basic unit is especially large. It can be seen that the first unit in such a chain can be handling many times the volume flow rate of air through its plenum compared with that flowing through its own nozzles. This, in conjunction with any primary air valves — particularly if they are duct mounted — can produce increased noise levels. The last unit in such a chain becomes equivalent to the single induction unit outlined in Section H.3.1.

To determine the total noise produced by an induction unit in such a series chain, excess primary air must be passed through the plenum and dumped from the exhaust end. For the purposes of the test, this dumping must be carried out external to the room and in such a manner so as not to produce extra in-duct noise. A constant/variable flow rate throttle in the branch duct is advantageous for minimisation of this noise level. A second noise check attenuator must be incorporated in this exhaust side of the test rig to carry out a similar check to that above (Section H.3.1) for noise produced by this damping throttle — Fig. H2.

The primary air supply is now not only discharging through the nozzles, but also passing through the plenum box to the exhaust. Hence, we additionally need to establish:

- a) the total primary air supply rate,
- b) the primary air discharging through the nozzles of the unit, and
- c) the primary air exhausting from the header box.

These three volume flowrates are simply related by addition and only two need be measured. The total primary air supply rate is measured as before from the quiet air supply. When calibration graphs are available linking the average nozzle pressure to the primary air flowrate through the nozzle then this should be employed to determine the total primary air discharge through the nozzles of the unit. Alternatively, the exhaust system can be fitted with a flow monitoring arrangement to measure exhaust volume flowrate, when the nozzle capacity can be determined by simple subtraction. By judicious use of the primary air valve or equal on the inlet to the unit and the exhaust damping throttle, a range of bypassing volume flowrates through the plenum box may be established, in conjunction with a range of nozzle volume flowrates. As before, each of these nozzle volume flowrates is associated with a secondary induced flow determined from independent aerodynamic tests. At each of these aerodynamic duties of primary air volume flow through the nozzles and primary air volume flow through the plenum box, the noise measurements shall be made as set out in Section H4 together with the nozzle static pressure and the upstream primary air supply static pressure $1\frac{1}{2}$ hydraulic diameters from the unit's inlet spigot.

It will still be necessary to consider additional primary air damper settings, to generate a range of upstream back pressures.

Each and every one of these involved throttle combinations may produce its own noise characteristics from:

- a) nozzle noise.
- b) primary inlet damper throttle noise, and
- c) plenum box flow noise.

Alternative secondary air damper settings may be employed and other nozzle arrangements tested. A set of noise measurements shall be recorded for each of these variables in combinations:

- a) total primary air supply rate.
- b) primary air discharging through the nozzles of the unit.
- c) primary air exhausting from the plenum box.
- d) secondary air damper setting.
- e) nozzle arrangement.

H.3.3 Operation During Test Ceiling-mounted Single Unit in a corner

This procedure will be identical to that of Section H.3.1 for the wall-mounted unit, but employing the corresponding noise measurement locations set out in Section H.4.1.2

H.3.4 Operation During Test Ceiling-mounted Units in Series

This procedure will be identical to that of section H.3.2 for the wall-mounted unit, but employing the corresponding noise measurement locations set out in Section H.4.1.2

H.3.5 Operation During Test Ceiling-mounted Single Unit not located in corner

This procedure will be identical to that of Section H.3.1 for the wall-mounted unit, but employing the corresponding noise measurement locations set out in Section H.4.1.3.

H.3.6 Operation During Test Ceiling-mounted not in a corner — Units in Series

This procedure will be identical to that of Section H.3.2 for the wall-mounted unit, but employing the corresponding noise measurement locations set out in Section H.4.1.3

H.4 NOISE MEASUREMENT

H.4.1 Location of Measurement Positions

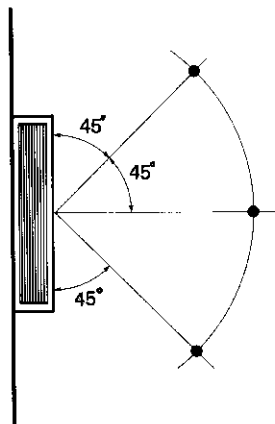
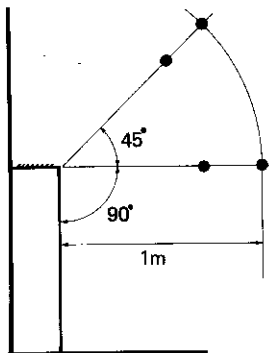
H.4.1.1 Wall-mounted Unit

Six microphone positions are to be used at 1 m distance from the outlet-air plane. Three of these positions shall be at 45° intervals in the horizontal plane the centre position being directly in front of the vertical centre line of the unit. The remaining three positions are to be at 45° intervals in a plane 45° above the horizontal with again the central position in front of the outlet as in Fig. H.3.

H.4.1.2 Ceiling-mounted units — corner location

Six microphone positions are to be used at 1 m distance from the outlet-air plane. Three positions are to be at 45° intervals in the vertical plane down from the unit such that the central position is directly below the outlet. The three other positions are to be in a plane at 45° rotated up from this vertical plane (away from the wall) in corresponding rotated locations — Fig. H.4.

Figure H3 Microphone positions for wall mounted unit



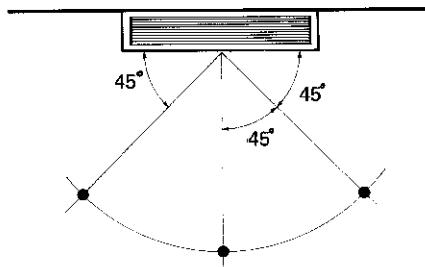
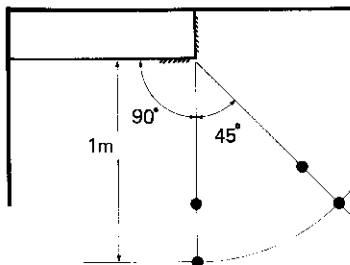
3 Positions at 45° intervals the central one being directly in front of the outlet.

3 Positions at 45° to the horizontal plane in corresponding locations.

H.4.1.3 Ceiling-mounted units, not located in a corner

Nine microphone positions are to be used at a 1 m distance from the outlet-air plane. Three positions are to be at 45° intervals in the vertical plane down from the unit such that the central position is directly below the outlet. Three positions are to be in a plane at 45° rotated up from this vertical plane in a clockwise direction in corresponding rotated locations. Three positions are to be in a plane at 45° rotated up from this vertical plane in an anti-clockwise direction — Fig. H.5.

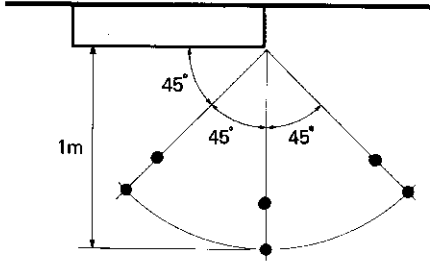
Figure H4 Microphone positions for ceiling mounted unit (corner location)



3 Positions at 45° intervals, the central one being directly below the outlet

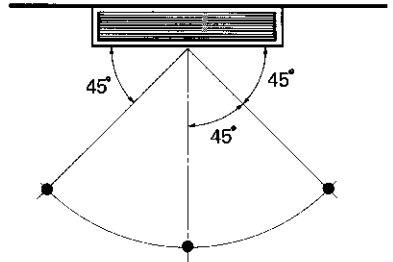
3 Positions at 45° to the vertical in corresponding locations

Figure H5 Microphone positions for ceiling mounted unit (not located in a corner)



3 Positions in vertical plane at 45° intervals one being directly below outlet.

3 Positions in each plane at 45° to the vertical plane in corresponding rotated locations.



H.4.2 Measurements of Sound Pressure Level

Sound pressure levels in each of the octave bands over the range of 63-8000 Hz. shall be recorded at each measurement position.

H.4.3 A-weighted Broad-band Sound Pressure Level

The broad-band A-weighted sound pressure level dBA shall be recorded at each measurement position.

H.4.4 Background Noise Levels

Background levels in each octave band at each measuring position shall be recorded before and after every test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

H.5 INFORMATION TO BE PRESENTED

This must include:

a) Type, size and model number of the test unit, also the name of the manufacturer.

- b) Type of unit and mounting location.
- c) Details of mounting arrangement.
- d) Primary air supply rate.
- e) Primary air damper setting duty — upstream static pressure reading.
- f) Nozzle pressure.
- g) Secondary induced air rate.
- h) Secondary air damper settings.
- i) Plenum boair volume flowrate.
- j) Nozzle arrangement.
- k) Background sound pressure levels.
- l) The real-room sound pressure level of the product for each setting tested shall be derived for each octave band, over the range 63-8000 Hz. according to the averaging procedure of Section 8.1 of the main document.
- m) The overall A-weighted level of the product for each setting tested the overall A-weighted level shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX J

J.1 AIR-CONDITIONING UNITS — FREE-STANDING

J.1.1 Scope

This portion of the appendix is concerned with the measurement of noise produced by free-standing air-conditioning units.

J.2 INSTALLATION AND OPERATION

J.2.1. Installation

The unit shall be placed centrally in the room and be free-standing on the floor using the unit's own feet/ castors.

Where the unit has adjustable air deflectors or grilles these shall be set to discharge in a horizontal plane.

In all other respects the unit shall be installed according to the manufacturer's installation and operating instructions.

J.2.2 Operation During Tests

Prior to commencing a test the unit shall have been operating for 30 minutes in order to establish stable running conditions. The thermostatic controls of the unit shall be set such that the compressor shall not cut out at any point during the test.

J.2.3 General

All accessories which are normally part of the standard unit, such as grilles, filters and air deflectors, shall be fitted to the unit for the test. Where accessories are optional extras, then tests should be performed with and without these fitted, with the results being recorded separately.

If the unit can be operated at more than one speed then sound level measurements shall be taken at each speed setting and the results recorded separately.

J.3 NOISE MEASUREMENT

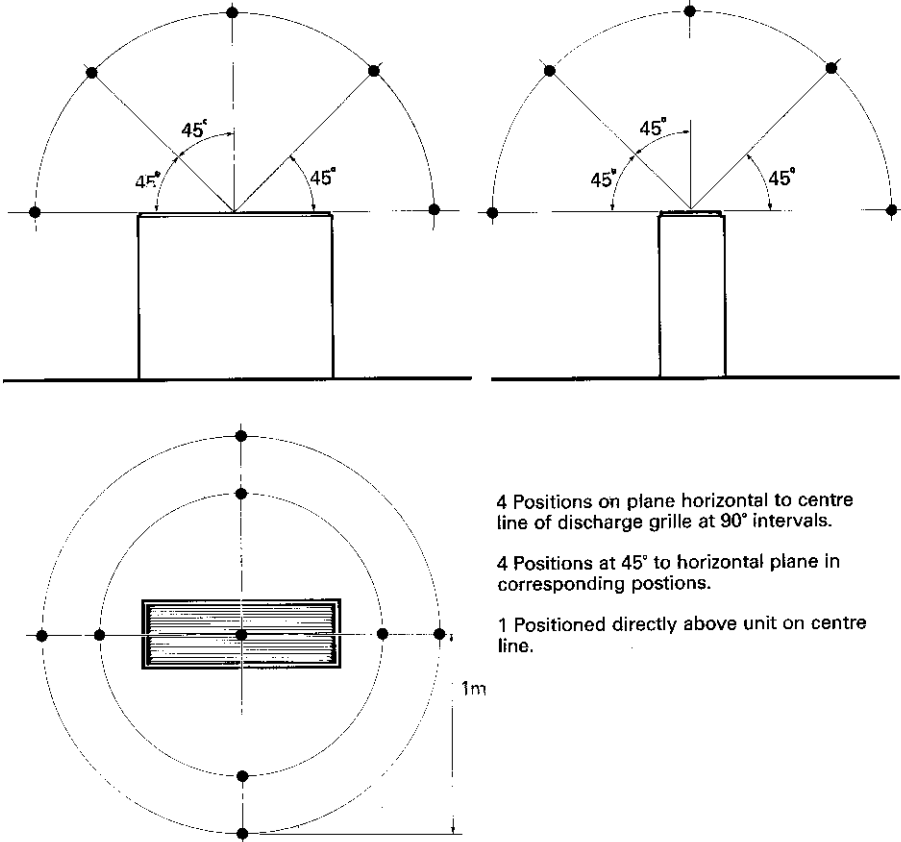
J.3.1 Location of Measurement Positions

Nine microphone positions, arranged hemispherically on a 1 m radius, as shown in Fig. J.1 shall be used.

J.3.2 Measurements of Sound Pressure Level

Sound pressure levels in each of the octave bands over the range 63-8000 Hz, shall be recorded at each measuring position.

Figure J1 Microphone Positions For Free Standing Air Conditioning Units



J.3.3 A-weighted Broad-band Sound Pressure Level

The A-weighted broad-band sound pressure level, dBA, shall be recorded at each measuring position.

J.3.4 Background Noise Levels

Background noise levels in each octave band at each measuring position shall be recorded before and after each series of tests to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

J.4 INFORMATION TO BE PRESENTED

This must include:

- a) Size and model number of the unit tested.
- b) Details of mounting arrangements and the units position in the room.
- c) Mode of operation — compressor operating.
- d) Details of electrical supply — measured voltage and nominal frequency.
- e) Details of accessories fitted (speed control, grilles, filters, air deflectors etc.).
- f) Background sound pressure levels in each octave band over the range 63-8000 Hz.
- g) The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz according to the averaging procedure of Section 8.1 of the main document.
- h) The overall A-weighted level of the product for each setting tested the overall A-weighted level shall be derived according to the averaging procedure of Section 8.2 of the main document.

J.5 AIR-CONDITIONING UNITS — SPLIT SYSTEM

J.5.1 Scope

This portion of the appendix concerned with the measurement of noise procedure by wall and ceiling mounted split system air-conditioning units made up to 8 kW. Provision is made for testing only the air-handling units; condensing units require testing in an external environment by a free-field method.

The indoor units can be tested in both wall and ceiling mounted modes. Units fitted with auxiliary heating arrangements, such as low pressure hot water coils (LPHW) or electrical resistance type elements, are also covered by this section.

J.6 INSTALLATION AND OPERATION

J.6.1 Installation

The indoor unit shall be centrally mounted on a 12.5 mm thick plywood panel which is in turn fixed to the wall or ceiling by timber studding. In order to ensure adequate stiffness of the plywood panel the studding shall be

arranged such that the vertical distance between studs does not exceed 600 mm and that there is horizontal cross bracing between studs at a maximum of 800 mm between centres.

For wall mounting, the unit shall be mounted such that the height to the bottom of the air intake grille(s) is a minimum of 500 mm from the floor and that the height from the top of the air discharge grilles is a minimum of 1250 mm below the ceiling. Units which cannot be mounted in accordance with these criteria are outside the scope of this test.

For ceiling mounting, the unit shall be mounted such that the air intake grille(s) is a minimum of 500 mm from the closest wall and such that the microphone positions in Fig. J.3, can be achieved.

The unit shall be piped up to a condensing unit sited outside the real room in such a manner that it shall not contribute to the background noise level in the real room.

In all other respects the unit shall be installed according to the manufacturer's installation instructions.

J.6.2 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

J.6.3 Operation During Tests

Where the discharge grille(s) can be set to discharge in either the horizontal or vertical planes, separate tests shall be carried out for each mode. Where adjustable air deflectors or diffusers are optional items separate tests shall be carried out with and without the items fitted.

Prior to commencing a test the unit shall have been operating for 30 minutes in order to establish stable motor running conditions.

The unit shall be operated with the refrigerant circuit in operation and with any thermostatic controls set such that the compressor shall not cut out at any point during the test.

Note: It may be necessary to provide heating to achieve this objective.

J.6.4 General

All accessories which are normally part of the standard unit, such as grilles, filters and air deflectors, shall be fitted to the unit for the test. Where accessories are optional then tests should be performed with and without these fitted, with the results being recorded separately.

Where a unit can be fitted with auxiliary heating devices then further tests shall also be carried out with these in operation and the results recorded separately.

J.7 NOISE MEASUREMENT.

J.7.1 Location of Measurement Positions

The measurement positions are detailed and shown in Figs. J.2 & J.3.

J.7.2 Measurements of Sound Pressure Level

Sound pressure levels in each octave band over the range 63-8000 Hz, shall be recorded at each measuring position.

J.7.3 A-weighted Broad-band Sound Pressure Level

The A-weighted broad-band sound pressure level dBA shall be recorded at each measuring position.

J.7.4 Background Noise Level

Background noise levels in each octave band shall be recorded before and after each series of tests to demonstrate that extraneous noises have been excluded from the measurements and that the necessary minimum separation of 6 dB has been achieved.

J.8 INFORMATION TO BE PRESENTED

This must include:

- Size and model number of the unit tested.
- Details of mounting arrangements.
- Mode of operation — refrigerant circuit in operation, compressor on continuously.
- Details of electrical supply — measured voltage and nominal frequency.
- Details of accessories fitted, (speed control, grilles, deflectors, louvres etc.) and including details of any auxiliary heating devices fitted. Setting of grilles, deflectors, and louvres.
- Background sound pressure levels in each octave band over the range 63-8000 Hz.
- The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz according to the averaging procedure of Section 8.1 of the main document.
- The overall A-weighted level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

J.9 AIR-CONDITIONING UNITS — THROUGH-WALL

J.9.1 Scope

This portion of the appendix is concerned with the measurement of noise produced by cased wall-mounted room air conditioning equipment, designed to provide free delivery of conditioned air directly into an enclosed space. Such equipment includes a source of refrigeration for cooling and dehumidification and means for the circulation and filtration of the air.

J.10 INSTALLATION AND OPERATION

J.10.1 Installation

In practice the air-conditioning units are normally mounted in an aperture made in the facade of a building, typically under a window as a console unit.

The under window console unit is normally without any part projecting outdoors, only the two air terminal grilles of the inlet and outlet of the condenser circuit being visible on the external wall face.

The unit under test is to be mounted on a 12.5 mm thick plywood panel on timber studding. The vertical studs shall be at not more than 600 mm centres with horizontal cross bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel. The mounting height is to be one metre from the floor to the centre of the air discharge grille.

Where the size and/or weight of the unit under test requires supports, internally and/or externally, these shall be fixed according to the manufacturer's instructions.

Where the discharge grilles can be set to discharge at angles other than normal to the casing axis, then separate tests shall be carried out for each of the chosen settings.

J.10.2 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

J.10.3 Operation During Test

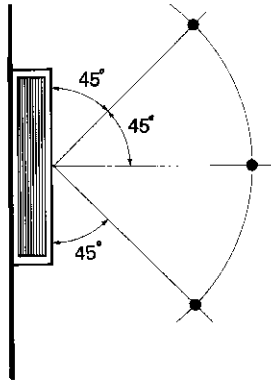
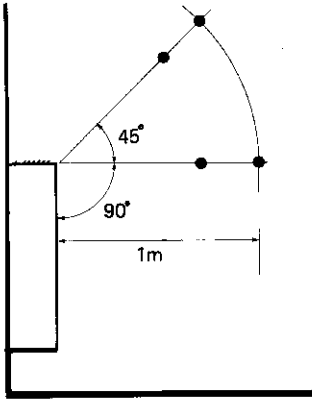
Prior to commencing a test the unit shall have been operating for 30 minutes to establish stable motor running conditions. The unit shall be operated with the refrigerant circuit in operation and with any thermostatic controls set such that the compressor shall not cut out at any point during the test. It may therefore be necessary to provide heating to achieve this objective.

J.10.4 General

All accessories which are normally part of the standard unit such as grilles, filters and air deflector vanes, shall be fitted to the unit for the test. Where such accessories are optional then tests should be done with and without them fitted, with the results being recorded separately.

If the unit can be operated at more than one setting in the cooling mode, then sound level measurements shall be taken at each of these settings and the results recorded separately.

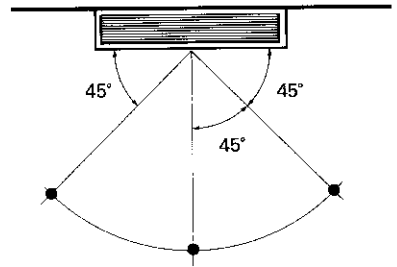
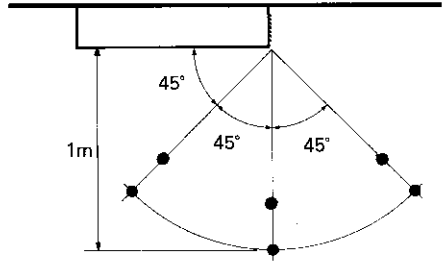
Figure J2 Microphone positions for wall mounted unit



3 Positions at 45° intervals the central one being directly in front of the outlet.

3 Positions at 45° to the horizontal plane in corresponding locations.

Figure J3 Microphone positions for ceiling mounted unit



3 Positions in vertical plane at 45° intervals one being directly below outlet.

3 Positions in each plane at 45° to the vertical plane in corresponding rotated locations.

Where a unit can be fitted with auxiliary heating devices, then further tests shall also be carried out with these in operation and the results recorded separately.

J.11 NOISE MEASUREMENT

J.11.1 Location of Measurement Positions

Six microphone positions are to be used at one metre distance from the outlet-air plane as shown in Fig. J.2. Three positions are to be at 45° intervals in the horizontal plane the centre position being directly in front of the centre line of the unit and three positions at 45° intervals in the plane 45° above the horizontal.

J.11.2 Measurement of Sound Pressure Level

Sound pressure levels in each of the octave bands over the range of 63-8000 Hz shall be recorded at each measuring position.

J.11.3 A-weighted Broad-band Sound Pressure Level

The A-weighted broad-band sound pressure level dBA shall be recorded at each measuring position.

J.11.4 Background Noise Levels

Background levels in each octave band are to be recorded before and after any test series to demonstrate

that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

J.12 INFORMATION TO BE PRESENTED

This must include:

- a) Size and model number of the test unit.
- b) Details of mounting arrangement.
- c) Mode of operation - compressor operating continuously.
- d) Details of electrical supply - measured voltage and nominal frequency.
- e) What accessories were fitted (speed control, grilles, louvres, deflectors etc).
- f) Background sound pressure levels in each octave band over the range 63-8000 Hz.
- g) The real-room pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz according to, the averaging procedure of Section 8.1 of the main document.
- h) The overall A-weighted level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX K

ROOF EXTRACT UNITS

K.1 Scope

This section is concerned with the testing of small roof mounted or wall mounted extract fans. Because of the size of the room only small units can be tested and this method is limited to units which do not require a roof or wall opening greater than one square metre in area.

K.2 INSTALLATION

K.2.1 Mounting

The unit to be tested shall be mounted over an opening in either the wall or ceiling of the test room. If the unit incorporates gravity operated shutters then it should preferably be mounted in its normal operating position but where this is not possible the unit shall first be set up in its normal attitude and run at the required duty point, and the position of the shutters noted. The shutters shall then be locked in this position and the unit mounted over the opening in the test room.

Note: where the mounting adopted is abnormal it may be necessary to modify the attachment of any resilient mountings so that they still continue to work with the unit in this abnormal attitude.

It is important that the surface on which the unit is mounted should not act as a sounding board and for this reason should preferably be of either brick or concrete construction. If a brick or concrete mounting surface is not available then the mounting shall be arranged as follows. The unit under test shall be mounted on a 12.5 mm thick plywood panel on timber studding. For a wall

mounting, the vertical studs shall be at not more than 600 mm centres with horizontal cross-bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel. The mounting height shall be 1 m from the floor to the centre of the grille of the air discharge or air inlet, as appropriate. For a ceiling-mounted unit the equivalent mounting on 12.5 mm plywood on timber studding at 600 mm centres cross-braced at 800 mm centres shall be used.

The dimensions of the opening shall be in accordance with the manufacturer's recommendations and the area of the opening, as stated above, must not exceed one square metre.

Where it is necessary to measure the noise on the discharge side, the unit may be mounted on the inner surface of the room discharging into the room. In this case it will probably be necessary to lock the shutters in position as described above.

K.2.2 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The centre line of an air intake should lie in the same axis as the centre line of the unit under test, otherwise there is a risk of setting up a vortex in the room which would affect both the noise levels and the air performance of the unit being tested. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation.

The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

K.2.3. Operation During Test

It is essential to start and run the unit for a minimum warm-up period of 30 minutes until steady-state running conditions are reached prior to commencing the tests.

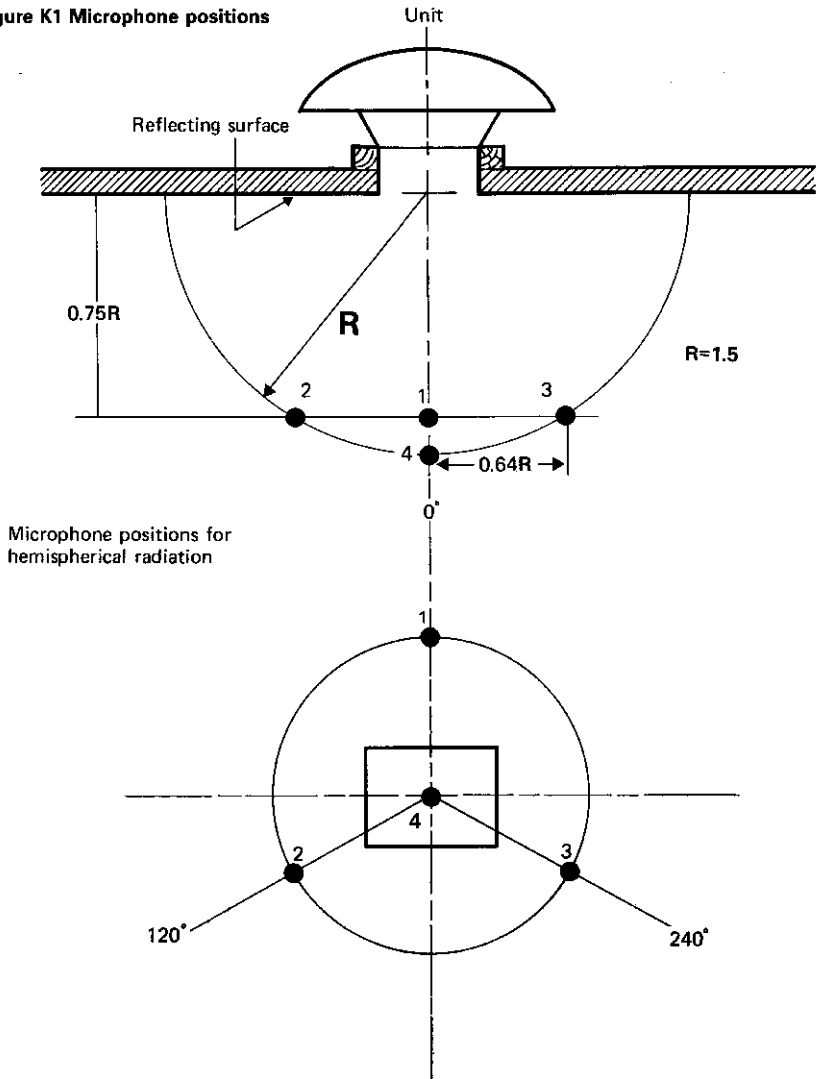
K.2.4 General

Any accessories which are normally part of the standard unit such as gravity shutters, resilient mounts etc shall be fitted.

Some units may have a speed selection facility. If so, sound level measurements shall be taken at each speed setting and recorded separately.

The air pressure against which the unit operates during the test shall be measured by a manometer connected to read the difference between the average static pressures in the four corners of the test room, adjacent

Figure K1 Microphone positions



to the surface on which the unit under test is mounted, and the average static pressure in the space in which the unit discharges. If the pressure/volume characteristic of the unit under test is known, this pressure will indicate the air volume being handled by the unit during the test.

K.3 NOISE MEASUREMENT

K.3.1 Location of Measurement Positions

Microphone positions shall be as shown in Fig. K.1.

K.3.2 Measurement of Sound Pressure Level

Sound pressure levels in each of the octave bands over the range 63-8000 Hz shall be recorded at each measuring position.

K.3.3 A-weighted Broad-band Sound Pressure Levels

The A-weighted broad-band sound pressure level dBA shall be recorded at each measuring position.

K.3.4 Background Noise Levels

Background levels in each octave band at each measuring position shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

K.4 INFORMATION TO BE PRESENTED

The report of the test(s) must include the following information:

- The size and model number of the unit under test.
- Details of the mounting arrangements.
- Mode of operation - intake or extract.
- Details of electrical supply - measured voltage and nominal frequency.
- Details of any accessories which are fitted (speed control, grilles, gravity shutters etc.).
- The background sound pressure levels in each octave band over the range 63-8000 Hz.
- A plot of the pressure-volume characteristics with the operating point(s) of the test marked on it.
- The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz according to the averaging procedure of Section 8.1 of the main document.
- The overall A-weighted level of the product for each setting tested, the overall A-weighted level shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX L

UNIT HEATERS

L.1 SCOPE

This appendix is concerned with the measurement of noise produced by cased fan powered heater units designed primarily for permanent wall or ceiling mounting arrangements. The heater section is normally positioned on the discharge side of a conventional axial flow or propeller fan, and consists of either a sheathed or open spiral shielded electrical element or a conventional heater battery using hot water or steam. Such unit heaters normally have provision for varying the warmed air discharge pattern either by angling the entire unit or by adjusting the discharge louvres. Other arrangements of fan and heater are not precluded.

L.2 INSTALLATION AND OPERATION

L.2.1 Mounting Procedure

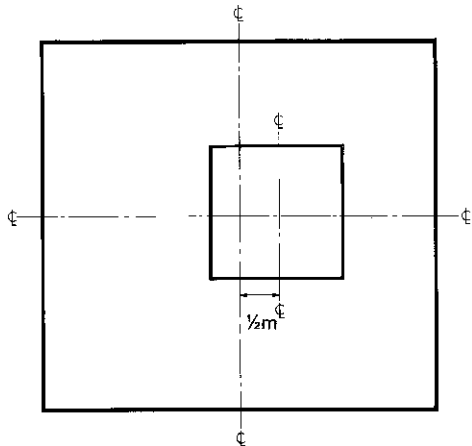
The unit under test is to be mounted on a 12.5 mm thick plywood panel on timber studding. The vertical studs shall be at not more than 600 mm centres with horizontal cross bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel. The unit shall be fixed strictly according to the manufacturer's instructions with any discharge louver blades in the fully open position.

The unit shall be positioned as shown in Fig. L.1 to achieve the required measuring positions above and below the horizontal centre line without getting the microphone too close to either the wall or the ceiling - see Section 7.1.

L.2.2 Operation During Tests.

The fans used in such units are frequently powered by low power motors for either single-phase or three-phase alternating current supplies. It is essential to start and run the unit for a minimum period of 30 minutes until steady-state running conditions are reached prior to commencing the tests.

Figure L1 Unit Mounting Positions



Elevation of wall mounting position

L.2.3 General

All accessories which are normally part of the standard unit, such as wire protection grilles, adjustable discharge louvres, filters, shall be fitted.

Some units may have an alternative speed selection facility, and the sound level measurements shall be taken at each alternative speed and recorded separately.

L.3 NOISE MEASUREMENTS

L.3.1 Location of Measurement Positions

Nine microphone positions shall be used at 1 m distance from the outlet-air plane. Three positions shall be at 45° intervals in the horizontal plane, the centre position being directly in front of the vertical centre line of the unit and three positions at 45° intervals in the planes 45° above and below the horizontal, as in Fig. L.2.

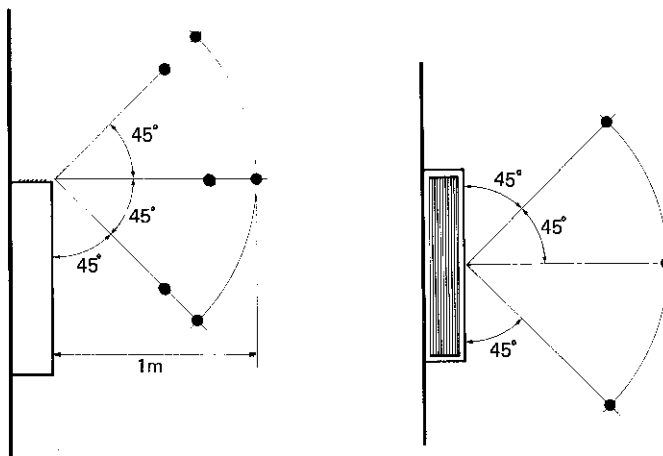
L.3.2 Measurements of Sound Pressure Level

Sound pressure levels in each of the octave bands over the range 63-8000 Hz shall be recorded at each measuring position.

L.3.3 A-weighted Broad-band Level

The A-weighted broad-band sound pressure level dBA shall be recorded at each measuring position.

Figure L2 Microphone positions



3 Positions in vertical plane at 45° intervals one being directly below outlet.

3 Positions in each plane at 45° to the vertical plane in corresponding rotated locations.

L.3.4 Background Noise Levels

Background levels in each octave band at each measuring position shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation has been achieved.

L.4 INFORMATION TO BE PRESENTED

This must include:

- Size and model number of the test unit heater.
- Details of mounting arrangements.
- Mode of operation.
- Details of electrical supply - measured voltage and nominal frequency; also the heater rating.
- If applicable, the details of hot water temperature and flowrate or steam pressure.
- What accessories were fitted (speed control, grilles, louvres, deflectors etc).
- Background sound pressure levels in each octave band over the range 63-8000 Hz.
- The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz, according to the averaging procedure of Section 8.1 of the main document.
- The overall A-weighted level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

APPENDIX M

WINDOW FANS

M.1 SCOPE

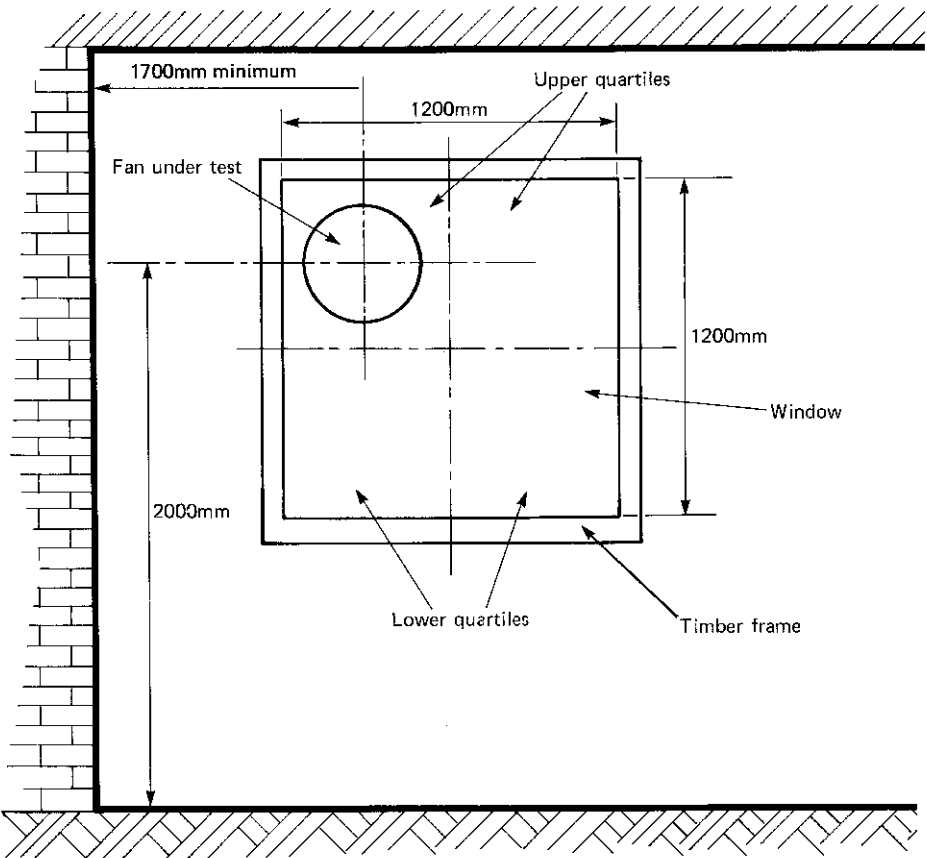
This appendix is concerned with the measurement of the noise produced by fans which are normally mounted over a hole cut in the window of the room which is being ventilated. The window fan to be tested is fitted into a standardized window, unless the fan unit is supplied with adaptors or special enclosures to enable it to be used wall mounted. Test procedures applicable to both types of installation are described below.

M.2 INSTALLATION AND OPERATION

M.2.1 Window Fans: Installation in Window

Fig. M.1 gives the dimensions and location of a standardised window which is to be installed through a brick wall of the test room. The window is to be timber framed, dry glazed and the glazed area shall be 1200 x 1200 mm. The glazing shall extend vertically from 1100 mm above the floor to 2300 mm above the floor. That side edge of the glazing which is nearer to the fan shall be not less than 1400 mm from the wall adjoining the wall in which the unit is installed. The fan under test shall be mounted in one of the upper quartiles of the glass and the method of mounting shall be in accordance with the manufacturer's published data.

Figure M1 Unit mounting position



M.2.2 Window Fans: Installation as a Wall-mounted Unit

The fan shall be mounted over a suitably sized hole in a brick wall of the test room and in accordance with the manufacturer's published data. If a brick or concrete mounting wall surface is not available then the mounting shall be arranged as follows. The unit under test shall be mounted on a 12.5 mm thick plywood panel on timber studding. The vertical studs shall be at not more than 600 mm centres with horizontal cross-bracing between studs at maximum 800 mm centres to ensure adequate stiffness of the plywood panel.

The fan axis shall be sited at a height of 2000 mm above the floor and at least 1700 mm from the nearer of the two adjoining side walls.

M.2.3 Air Balance

An additional attenuated, balancing airway shall be provided into the test room, but not in the surface in which the product is mounted. The attenuated airway must have at least 5 dB of static insertion loss in each of the octave bands from 125-8000 Hz.

An attenuator is employed to ensure that the balance airway is, indeed, sufficiently quiet for each of the tests carried out. It must be established that on insertion of this attenuator the measured noise level for any test operating condition does not decrease by greater than 1 dB in each of the octave bands under investigation. The tests will be carried out with the balancing airway attenuator in place to ensure that the entry/outlet of air is sufficiently attenuated for the tolerance required of this test technique.

During the test the average velocity through this balancing airway, taken over the whole face area, shall not exceed 2 m/s.

M.2.4 General

The fan shall be complete with any accessories normally fitted to a standard unit (eg grilles and backdraft shutters). The noise output of the fan when fitted with optional features, such as filters or lightproof cowls, may differ significantly from that of a standard fan and must be reported separately.

If the fan is normally supplied with a speed control, then this shall be fitted and, in the case of a stepped speed control, noise measurements carried out at each of the control positions. If an infinitely variable speed control is usually supplied, noise measurements shall be made at full-speed and at three-quarter and half of the maximum speed.

Where a reversing facility is normally provided, then noise measurements shall be made with the fan operating in both the supply and the exhaust modes.

The pressure difference across the fan under test is to be measured with a suitable manometer and during the test this pressure difference shall not exceed 10 Pa.

M.2.5 Operation During Test

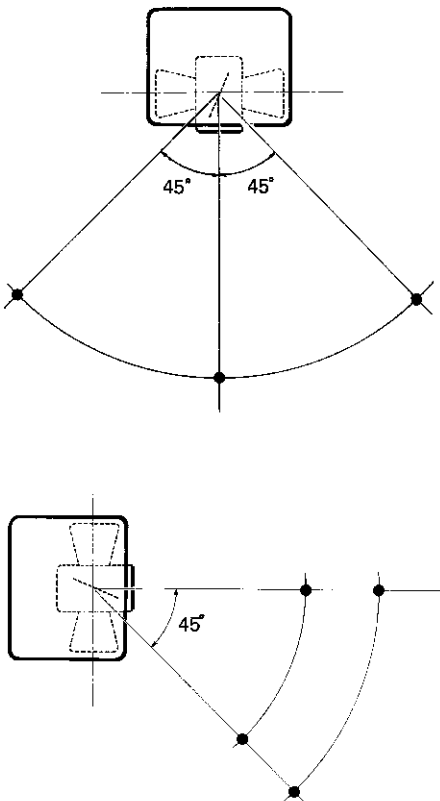
If adjustable louvres/grilles are fitted then separate tests shall be performed with these set to 0°, 22° and 45° downward angle. Any backdraft shutters fitted shall be fully opened throughout the tests or, if fan operated, open to the extent determined by the fan. Where speed is selectable or controllable the test speed and the control setting should be recorded for each test.

M.3 NOISE MEASUREMENT

M.3.1 Location of Measurement Positions

Six microphone positions are to be used, as shown in Fig. M.2 each position shall be 1 m from the intersection of the fan axis and the centre line of the blades. Three positions are to be at 45° intervals in the horizontal plane, the centre position being directly in front of the vertical centre line of the unit and three positions at 45° below the horizontal.

Figure M2 Microphone positions



3 Positions at 45° on plane horizontal to to centre line of unit.

3 Positions at 45° to horizontal.

M.3.2 Measurement of Sound Pressure Level

Noise measurements shall be made using the procedure given in Sections 6-8 of the main document.

Sound pressure levels in each of the octave bands over the range 63-8000 Hz shall be recorded at each measuring position.

M.3.3 A-weighted Broad-band Sound Pressure Level

The A-weighted broad-band sound pressure level dBA shall be recorded at each measuring position

M.3.4 Background Noise Levels

Background levels in each octave band shall be recorded before and after any test series to demonstrate that extraneous noises have been excluded from the measurements and that the necessary 6 dB separation above background levels has been achieved.

M.4 INFORMATION TO BE PRESENTED

The report of the test(s) must include the following information:

- a) Size and model number of the fan under test.
- b) Details of the mounting (window or wall).
- c) Mode of operation - intake, extract only or reversible.
- d) Details of electrical supply - measured voltage and nominal frequency.
- e) What accessories were fitted (backdraft shutters, weatherproof cowls etc).
- f) The setting(s) and, if applicable, the rotational speed(s) at which the fan was tested. Where applicable results shall be taken for both intake and exhaust modes.
- g) Background sound pressure levels in each band recorded over the range 63-8000 Hz.
- h) The real-room sound pressure level of the product for each setting tested shall be derived for each octave band over the range 63-8000 Hz. according to the averaging procedure of Section 8.1 of the main document.
- i) The overall A-weighted level of the product for each setting tested shall be derived according to the averaging procedure of Section 8.2 of the main document.

Publications referred to in this document:—

BS 848:— Fans for general purposes		BS 4196:Part 2:1981 Precision methods for determination of sound power levels for discrete-frequency and narrow-band sources in reverberation rooms	=ISO 3742
BS 848:Part 2:1985 Methods of noise testing		BS 4196:Part 3:1981 Engineering methods for determination of sound power levels for sources in special reverberation test rooms	=ISO 3743
BS 1042:— Measurement of fluid flow in closed conduits		BS 4196:Part 4:1981 Engineering methods for determination of sound power levels for sources in free-field conditions over a reflecting plane	=ISO 3744
BS 1042:Section 2.1:1983 Method using Pitot static tubes	=ISO 3966	BS 4196:Part 5:1981 Precision methods for determination of sound power levels for sources in anechoic and semi-anechoic rooms	=ISO 3745
BS 1042:Section 2.2:1983 Method of measurement of velocity at one point of a conduit of circular cross section	=ISO 7145	BS 4196:Part 6:1981 (1986) Survey method for determination of sound power levels of noise sources	=ISO 3746
BS 2475:1964 Specification for octave and one-third octave band-pass filters	=IEC 225	BS 4197:1967 (withdrawn) A precision sound level meter (Replaced by BS 5969:1981)	
BS 3638:1963 Method for the measurement of sound absorption coefficients (ISO) in a reverberation room	=ISO 354	BS 5969:1981 Specification for sound level meters (Replaces BS 3489:1962 and BS 4197:1967)	=IEC 651
BS 4196:— Sound power levels of noise sources		BS 6698:1986 Specification for integrating-averaging sound level meters	=IEC 804
BS 4196:Part 0:1981 (1986) Guide for the use of basic standards and for the preparation of noise test codes	=ISO 3740	Statutory Instrument 1975 No 1763 — The Noise Insulation Regulations 1975	
BS 4196:Part 1:1981 Precision methods for determination of sound power levels for broad-based sources in reverberation rooms	=ISO 3741	Statutory Instrument 1975 No 460 (S60) — The Noise Insulation (Scotland) Regulations 1975	