

Fans for general purposes —

Part 2: Methods of noise testing

Committees responsible for this British Standard

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Foreword

This Part of BS 848 has been prepared under the direction of the Machinery and Components Standards Committee and is a revision of BS 848-2:1966, which is withdrawn.

This standard describes four methods for determination of the sound power radiated by fans in each of the standardized installation types described in BS 848-1.

Installation type A: free inlet, free outlet.

Installation type B: free inlet, ducted outlet.

Installation type C: ducted inlet, free outlet.

Installation type D: ducted inlet, ducted outlet.

The terms used in this classification have the following meanings. Free inlet or outlet signifies that the air enters or leaves the fan directly from or to the unobstructed free atmosphere, except that, in type A installations, a partition in which the fan is mounted may support a pressure difference between the inlet and outlet sides. Ducted inlet or outlet signifies that the air enters or leaves the fan through a long, straight duct directly connected to the fan inlet or outlet respectively.

These standardized airways recognize that fan performance is influenced by the presence or otherwise of ducting connected to the fan.

The four methods of fan noise testing described are the in-duct, the free field, the reverberant field and the semi-reverberant field methods. It is not likely that these methods will permit determination of sound power in all on-site conditions, although the semi-reverberant field method will provide practical guidance for those few cases beyond the scope of the free field and semi-reverberant methods described in clause 8 of this standard.

This standard is concerned with the testing of fans under laboratory conditions. Fans which are too large to be tested in an acoustic laboratory or fans whose noise output is measured in the presence of an appreciable amount of background noise, as is often the case when testing on site, require the use of different techniques from those discussed herein (e.g. sound intensity measurements). Such tests, however, are outside the scope of this standard.

The frequency range to be determined has been extended in this revision to include the 63 Hz octave band, whilst the band width for measurement has been reduced to one-third octave to allow assessment of the presence of narrow band noise sources such as blade passing frequencies. The band width used for reporting information remains as octave bands and the precision of measurement has been evaluated to include effects of duct end impedances, transitions, noise sampling, instrumentation calibration and computation of sound power from sound pressure levels. Information on scaling of fan sound power and frequency from one fan size and/or speed to another is also included.

The sampling tube has been included for noise measurements in in-duct test environments where wind shielded microphones are necessary. These tubes are directional and are used to suppress the turbulent pressure fluctuations at the microphone. Therefore only the sound pressure attributed to the fan noise radiation is measured. These tubes are commercially available.

In order that the fan noise should be representative of the fan in one of the standardized installation types, intermediate airways have been specified corresponding to those parts of the common airway sections included in clause 24 of BS 848-1:1980 adjacent to the inlet and outlet of ducted fans. In the case of B and D type installations the outlet side flow straightener has been removed, since it might interfere with the acoustical measurements; simultaneous determination of standardized air and noise performance is not then possible.

Data obtained in accordance with this standard may be used for the following purposes amongst others:

- a) comparison of fans which are similar in size and type;
- b) comparison of fans which are different in size and type;
- c) rating of fans in terms of any constituent of its sound power level;
- d) scaling of fan noise from one size and speed to another size and speed;
- e) prediction of sound pressure levels in an installation of which the fan forms a part.

NOTE The prediction of near field sound pressure levels is not practicable. For example, a sound pressure level at 1 m is only appropriate if this represents a far field condition. This may limit the size and type of fan for which direct measurements are appropriate. (See clause 8.)

This standard describes a series of methods for the laboratory determination of fan sound power levels to form an integral part of the statement of complete fan performance, including noise for one of the installations of types A, B, C or D shown in BS 848-1. The sound power radiated by a fan in each of these installation types comprises: an inlet sound power; an outlet sound power; and a casing and/or drive sound power.

These sound powers are determined individually, or in combinations as follows:

- type A free inlet and part¹⁾ of casing sound power;
- type A free outlet and part¹⁾ of casing sound power;
- type B free inlet and casing sound power;
- type B ducted outlet sound power;
- type C ducted inlet sound power;
- type C free outlet and casing sound power;
- type D ducted inlet sound power;
- type D ducted outlet sound power.

The sound powers leaving a fan inlet into free space and into a duct are different, and each is also affected by what is connected to the outlet, and therefore the outlet acoustical impedance. Similarly, the sound powers leaving a fan outlet into free space and into a duct are different, and each is also affected by what is connected to the inlet, and therefore the inlet acoustical impedance. Eight sound powers are therefore required for a complete statement of the standardized performance of a fan adaptable to all installation types. It is, however, permissible to group some sound powers together provided they are only slightly different, as found in many instances.

The casing and, if required, the drive sound power may be determined in a type D installation test either by the reverberant field method (see 7.3.8) or by the free or semi-reverberant field methods (see 8.3.8).

In this standard the computation of sound power from sound pressure level measurements is based on the premise that the mean-square sound pressure averaged over the enveloping measuring surface and over time is:

- 1) directly proportional to the sound power output of the source;
- 2) inversely proportional to the area, S_m , of the measurement surface or to the equivalent absorption area, S_a , of the room;
- 3) otherwise dependent only on the physical constants of air density and sound velocity.

NOTE In view of the fact that sound transmitted along ducts is often modified prior to reaching the environment in which its effect is felt, the use of an A-weighted in-duct sound power level cannot be recommended.

¹⁾ This depends on the location of the partition.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 50, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 848 deals with the determination of the acoustic performance of fans designed to be capable of operating against a difference of pressure and may be used to determine the sound power of a fan combined with an ancillary device such as a roof-cowl, damper or fan silencer. They may be of the axial, centrifugal, mixed flow or other type. Fans designed solely for air circulation, such as ceiling fans or table fans, are excluded.

The uncertainty of measurement applies primarily to the steady broad-band noise as defined in ISO 2204 as emitted by fans. Prominent narrow-band and discrete frequency noise is determined only insofar as it can be deduced from an analysis in third-octaves with increased uncertainty of measurement. Narrow-band or discrete frequency levels in a reverberant chamber can only be accurately determined by the method of BS 4196-2, or in an anechoic chamber by the method of BS 4196-5.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 848 the definitions given in BS 661 apply together with the following.

2.1

free field

a sound field in a homogeneous, isotropic medium free of boundaries

NOTE In practice, it is a field in which the effects of the boundaries are negligible over the frequency range of interest.

2.2

free field over a reflecting plane

a sound field in the presence of one reflecting plane on which the source is located

2.3

anechoic room

a test room whose surfaces absorb essentially all the incident sound energy over the frequency range of interest, thereby affording free-field conditions over the measurement surface

2.4

semi-anechoic room

a test room with a hard reflecting floor whose other surfaces absorb essentially all the incident sound energy over the frequency range of interest, thereby affording free-field conditions above a reflecting plane

2.5

reverberation room

a reverberant test room complying with this standard

2.6

reverberant sound field

that portion of the sound field in the test room over which the influence of sound received directly from the source is negligible

2.7

semi-reverberant room

a semi-reverberant test room complying with this standard

2.8

semi-reverberant sound field

a sound field in which the level of diffuse field is at least 2 dB less than the free field level

2.9

diffuse field

an acoustic field in which the sound pressure level does not vary with position

2.10

surface sound pressure or sound pressure

the sound pressure averaged in time on a mean-square basis and also averaged over the measurement surface using the averaging procedures specified in 6.5.5.2, 7.5.4 and 8.7.5

2.11

sound pressure level, L_p

ten times the logarithm to the base 10 of the ratio of the square of the sound pressure to the square of the reference sound pressure. The reference sound pressure is 20 μPa

NOTE The width of the frequency band used has to be stated for example, one-third octave band, octave band, or overall. Flat-response metering is assumed unless otherwise stated, as in A-weighted overall sound pressure level.

2.12

space averaged sound pressure level, $\bar{L}_p$

the spaced average sound pressure level over the measuring positions or measurement surface respectively

2.13

mean-square sound pressure

the sound pressure averaged in space and time on a mean-square basis is denoted by $\langle \bar{p}^2 \rangle$. In practice, space/time-averaging over a finite path length or a fixed number of microphone positions, as well as deviations from the ideally reverberant sound field, lead only to an estimate of $\langle \bar{p}^2 \rangle$, called p_{av}^2

2.14**sound power level, L_w**

ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power. The reference sound power is 1 pW ($= 10^{-12}$ W)

NOTE 1 The mean sound pressure level at some reference radius is numerically different from the sound power level and its use in lieu of the sound power level although permissible is not recommended.

NOTE 2 The width of the frequency band used has to be stated for example, one-third octave band, or overall. Flat-response metering is assumed unless otherwise stated.

2.15**inlet sound power level**

the sound power level of a fan determined at the fan inlet in a specified test installation, type A, B, C or D

2.16**outlet sound power level**

the sound power level of a fan determined at the fan outlet in a specified test installation, type A, B, C or D

2.17**frequency range of interest**

for general purposes, that frequency range including the octave band with centre frequencies between 63 Hz and 8 000 Hz and the one-third octave band with centre frequencies between 50 Hz and 10 000 Hz. For special purposes it may be extended at either end, provided the test environment and instrument accuracy are satisfactory for use over the extended frequency range. For sources which radiate predominantly high (or low) frequency sound, it may be limited in order to optimize the test facility and procedures

NOTE Any band in which the level is more than 50 dB below the highest band pressure level need not be reported.

2.18**measurement surface**

a hypothetical surface of area S on which the measuring points are located. It envelopes the source

2.19**measurement distance**

the distance from the source to the measurement position

2.20**measuring plane**

the radial plane in the test duct in which the microphone is located

2.21**direct method**

that method in which the sound power level is calculated from the measured sound pressure levels produced by the source in a reverberation room and from the volume and reverberation time of the room

2.22**fan inlet and outlet area**

the gross area at the inlet or outlet section of the fan without deduction for motors, fairings or other obstruction

2.23**duct**

the arrangement comprising the intermediate duct, the test duct, and the terminating duct. The ducts are of circular cross section, straight and uniform, except that the intermediate duct may comprise a rectangular to circular transition

2.24**intermediate duct**

the duct used on the inlet and/or discharge side to ensure standardized flow conditions. It connects the fan through a transition duct where necessary to the test duct or the terminating duct

2.25**test duct**

the duct in which the fan sound power is measured

2.26**terminating duct**

the duct on the opposite side of the fan to that on which the acoustic tests are made

2.27**foam ball**

a windshield made of a specially prepared type of open-pored polyurethane sponge to attenuate wind noise at the microphone

2.28**sampling tube**

a tubular windshield designed for minimum sensitivity to flow noise and designed to be attached to a standard microphone

2.29**transition**

an airway along which there is a gradual change of cross-sectional area and/or shape

2.30**anechoic termination**

an element fitted to the end of a test or terminating duct in order to reduce the reflection of noise to a prescribed level (see 6.2.5)

3 Symbols and units

Symbol	Description	Unit	Symbol	Description	Unit
a	index used for conversion rules		L_{go}	sound power level at specified speed	dB
A	area of fan inlet or outlet	m ²	$L_{p,mult}$	the uncorrected space and time averaged sound pressure level for in-duct measurement using a multiplexer only	dB
A_x	cross-sectional area of an airway at section “x”	m ²	$L_{p,trav}$	the uncorrected space and time averaged sound pressure level for in-duct measurement using a circumferential traverse only	dB
b	index used for conversion rules		L_{pci}	correct sound pressure level at the i th position	dB
b_1	greater dimension of rectangular fan inlet	m	$\bar{L}_{pci}$	corrected time averaged sound pressure level measured at the i th position	dB
b_2	greater dimension of rectangular fan outlet	m	$\bar{L}_p$	space and time averaged sound pressure level	dB
B	a temperature and pressure correction term	—	L_p	sound pressure level	dB
B_w	band width	Hz	L_{pi}	uncorrected time averaged sound pressure level measured at the i th position	dB
c	speed of sound	m/s	L_w	sound power level	dB
C	combined response correction	dB	L_{wt}	sound power level at test speed	dB
C_1	microphone response correction	dB	L_{xy}	length of airway from “x” to “y”	m
C_2	windshield correction for the sampling tube, nose cone or foam ball	dB	L_1	length of airway adjacent to fan inlet	m
C_3	flow velocity correction for the frequency response required by the use of the sampling tube	dB	L_2	length of airway adjacent to fan outlet	m
C_4	modal correction for the induct frequency response required by the use of the sampling tube, nose cone or foam ball	dB	M_a	mach number = $\sqrt{\left[\frac{\rho v^2}{\gamma p}\right]}$	—
C_5	wind generated false noise correction	dB	n	fan speed	r/s
NOTE $C = C_1 + C_2 + C_3 + C_4 + C_5$			n_o	fan specific speed	r/s
D	diameter of test duct	m	n_t	fan test speed	r/s
D_R	impeller diameter	m	N	number of microphone stations	—
D_e	equivalent diameter	m	p	absolute pressure	Pa
D_m	diameter of induct microphone location	m	P	power	W
D_o	characteristic dimension (see 8.4.3)	m	r	a radius	m
f	frequency	Hz	S_a	total sound absorption area of test room	m ²
f_c	band centre frequency	Hz	S_r	total surface area of test room	m ²
$F(p, t)$	function of pressure and temperature (see G.2.1)		S_m	area of field measurement surface	m ²
h_1	lesser dimension of rectangular fan inlet	m	S_i	area associated with i th measuring point	m ²
h_2	lesser dimension of rectangular fan outlet	m	t	temperature	°C
H	a distance (see 8.4.3)	m	T	reverberation time	s
K	environmental correction factor	dB	U	peripheral speed	m/s
L_g	experimental function of f_c and n (see G.2.1)	dB	v	velocity of air at a point	m/s
			V	volume of test room	m ³
			W	sound power	W

Symbol	Description	Unit
x	cartesian coordinates	
y		
z		
θ	absolute temperature	K
ρ	density	kg/m ³
χ	a function of speed and frequency (see G.2.1)	—
ν	kinematic viscosity, μ/p	m ² /s
μ	dynamic viscosity	Pa s
γ	ratio of specific heats for perfect gas	—

4 Test methods, general

4.1 Test environment

Noise testing may be performed in a number of different test environments including:

- a prescribed test duct with nearly anechoic termination, for the determination of inlet or outlet in-duct sound power;
- an essentially spherical free field, either indoors or outdoors;
- an essentially hemispherical free field over a reflecting plane either indoors or outdoors;
- a reverberation room in accordance with 7.2, for the determination of open inlet, open outlet or casing radiated sound power.

4.2 Character of noise radiation by the fan

The uncertainty of measurement applies primarily to the steady broad-band noise as defined in ISO 2204 as emitted by fans. Prominent narrow-band and discrete frequency noise is determined only insofar as it can be deduced from analysis in third-octaves with increased uncertainty of measurement. Narrow-band or discrete frequency levels in a reverberant chamber can only be accurately determined by the method of BS 4196-2, or in an anechoic chamber by the method of BS 4196-5.

4.3 Frequency range

The frequency range is the one-third octave band centre frequencies from 50 Hz to 10 kHz.

4.4 Quantities to be measured

4.4.1 Sound pressure levels in frequency bands at different positions in one cross-sectional plane in an anechoically terminated duct.

4.4.2 Sound pressure levels over prescribed measurement surface or at several discrete microphone positions.

4.5 Quantities to be determined

The following quantities shall be determined. Sound power levels in third octave frequency bands of sound radiated into a duct or into a free space.

NOTE In general an A-weighted sound power has no physical meaning but is sometimes used as an index of quality. The use of A-weighted sound power levels should be limited to reference to measurements made in a free space, i.e. unducted. In these cases the term L_{pA} will be taken to mean the A-weighted sound pressure level at a hypothetical radius of 3 m under hemispherical or spherical radiation. The term L_{wA} is then the equivalent sound power level of the source calculated from that data.

4.6 Uncertainty of sound power level determination

Determination of sound power made in accordance with this standard will tend to result in an uncertainty of sound power level given in terms of the standard deviation shown in Table 1. The standard deviations given in this table reflect the cumulative effects of all causes of measurement uncertainty such as source location, duct end reflections, duct transitions, instrument calibration, sound pressure to sound power computing and sampling errors. The standard deviation given in the table are those which would be expected if the measurement were repeated in many different laboratories. It does not include variations in the sound power radiated by the fan itself caused by changes in the mounting arrangements for example. Care should be taken to obtain the specified time average. See Appendix A.

4.7 Test classifications

Only two classifications of test are necessary when measuring fans to determine sound power levels. If the fan has a duct on the inlet and/or outlet side then the sound power levels on the sides which are ducted have to be determined by an in-duct method. If the fan is unducted on the inlet and/or outlet side then the sound power levels on the sides which are unducted have to be determined by a method where sound pressure levels are measured on a measurement surface or at discrete points enveloping the fan.

NOTE The second classification can use an anechoic or semi-anechoic room or a reverberation chamber provided the fan size permits qualification of the room or chamber. When the fan size is sufficiently large such that the anechoic or semi-anechoic or reverberation chamber cannot be used then the semi-reverberant method may be applied. It should be noted that this method may be used even for the case where the fan size is small.

All test methods specified in this standard provide similar levels of uncertainty (see 4.6).

Table 1 — Uncertainty in determination of the broad band sound power levels

One-third octave band centre frequencies	Method of test				
	In-duct	Reverberant field	Spherical free field	Free field over reflecting plane	Semi- reverberant
	Standard deviations				
Hz	dB	dB	dB	dB	dB
50	3.5	5.0	No information available		
63	3.0	4.0			
80	2.5	3.5			
100	2.5	3.0	3.0	3.0	3.0
125	2.0	3.0	3.0	3.0	3.0
160	1.6	3.0	3.0	3.0	3.0
200	1.6	2.0	3.0	3.0	3.0
250	1.6	2.0	2.0	2.0	2.0
315	1.6	2.0	2.0	2.0	2.0
400 to 630	1.6	1.5	2.0	2.0	2.0
800 to 2 500	1.6	1.5	1.5	1.5	1.5
3 150 to 4 000	2.0	1.5	1.5	1.5	1.5
5 000	2.5	1.5	1.5	1.5	1.5
6 300 to 8 000	2.5	3.0	3.0	3.0	3.0
10 000	4.0	3.0	3.0	3.0	3.0

NOTE 1 For the in-duct method the measurement uncertainty may be lowered by careful construction of the test set-up by eliminating transition ducts, and by use of more absorptive terminating ducts (see Appendix A).

NOTE 2 The 95 % confidence limits may be calculated for a normal distribution of data by multiplying the quoted standard deviation by the factor 2.0.

NOTE 3 For a reverberation room the size of room is limited to a minimum of 180 m³ and the standard deviations quoted refer therefore to a room qualified to 100 Hz. Qualification to 50 Hz would require a room too large for practical inclusion in this standard.

NOTE 4 When octave band sound power levels are calculated, the uncertainty of each octave band level will not be greater than that of the largest uncertainty of the three constituent one-third octave bands.

NOTE 5 At low frequencies the value of standard deviation in the reverberant field is dependent (related) to the decibel range of sound pressure level and room absorption characteristics. The approximate value of standard deviation may be found by reference to Table 5(a).

4.8 In-duct method

Clause 6 describes a method of testing ducted fans to determine the sound power radiated into an anechoically terminated duct on the inlet and/or outlet side of the equipment. It applies to air temperatures of – 50 °C to + 70 °C.

The minimum test duct diameter is 0.15 m. This limits the minimum size fan connection to an equivalent diameter of 100 mm. The maximum flow velocity is 30 m/s as the flow noise suppression of the sampling tube may be insufficient at higher velocities. Normally, for swirl angles up to 10 °C flow noise suppression of the sampling tube is adequate; for higher angles of swirl refer to the procedures of Appendix B, or use may be made of the foam ball.

4.9 Reverberant field method

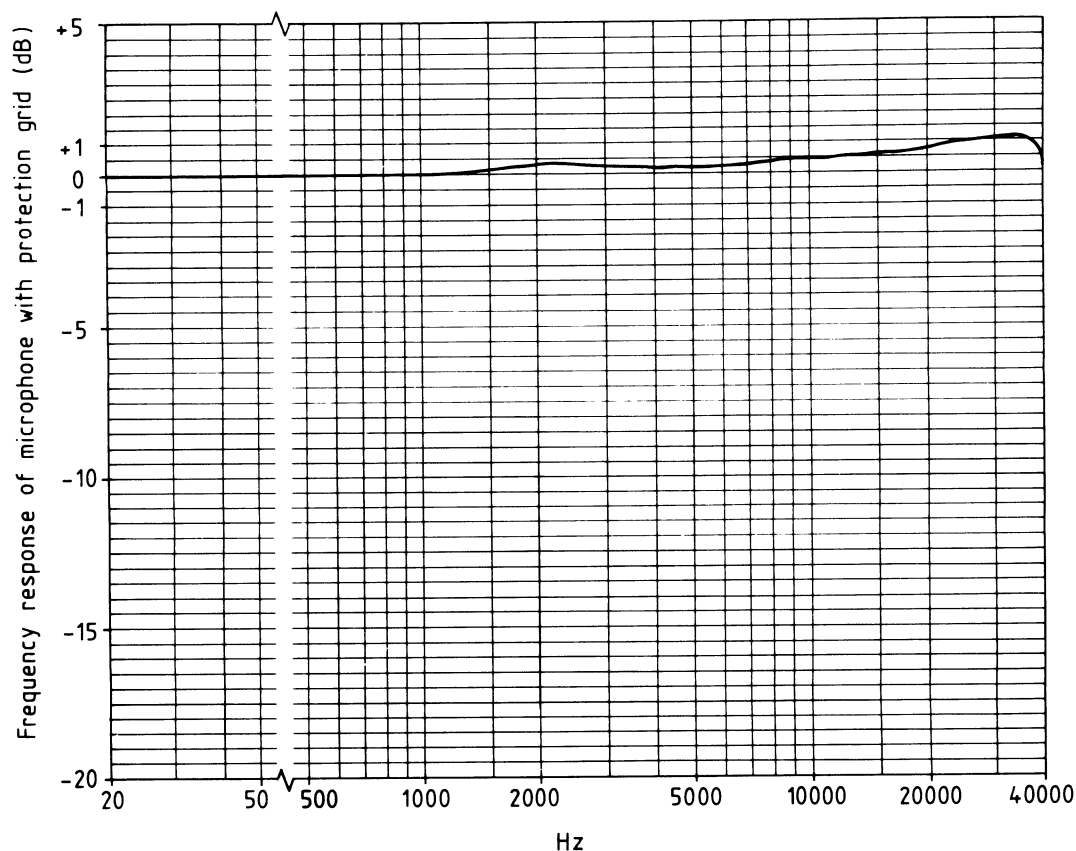
Clause 7 describes test room requirements, source location and operating conditions, instrumentation and techniques for obtaining an estimate of mean-square sound pressure from which the sound power level of the source is determined.

NOTE Most reverberant rooms of 180 m³ volume enable fan connection sizes up to 1 m² inlet or outlet area to be tested.

4.10 Free field method

Clause 8 describes the acoustic requirements for the measurement of noise under free-field conditions either in an anechoic field or over a reflecting plane and gives detailed requirements for the mounting of the fan under test as well as the descriptions of the operating conditions, measurement surfaces, minimum number of microphone positions, and the measurement distance to be used and the techniques for obtaining the sound power level of the source.

Fan connection size is limited only by the need to qualify a measurement surface outside the near field of the source and within the far field where the inverse square law applies.



NOTE The values of C_1 derived from this graph are given in Table 2.

Figure 1 — Example of frequency response of microphone fitted with protection grid as supplied by a manufacturer

4.11 Semi-reverberant method

In addition to the information referred to in 4.10, clause 8 also describes a method for use in a semi-reverberant environment whereby sound pressure levels measured on a hypothetical surface enveloping the fan enable the sound power level produced by the fan to be calculated. It gives the requirements of the test environment and instrumentation as well as techniques for obtaining the sound power levels.

The fan connection size is limited by the need to qualify the permitted measurement surfaces.

5 Instrumentation

5.1 Measuring system

5.1.1 General. The instrumentation system comprises a microphone, an amplifier with filters, a squaring and averaging circuit and a sound pressure level indicating device. There are several methods of processing or conditioning the filter outputs that may be used to obtain an estimate of the mean square value of the output. These include use of detection equivalent to RC-smoothing, integration of the squared value of the filter outputs and digital methods. Examples of suitable systems are given in Appendix C.

5.1.2 Microphone. A microphone of a standardized sound level meter of type 1 complying with BS 5969, shall be used. If a sampling tube is used the dimensions of the microphone shall be compatible with it. The correction C_1 for frequency response shall be supplied by the instrument manufacturer.

NOTE The instrument response has the opposite sign to the correction that should be applied to the reading. See Figure 1 and Table 2 for a typical example of an instrument's response.

5.1.3 Microphone cable. The microphone/cable system shall be such that the sensitivity does not change with the temperature in the range encountered in the test. Cable flexing due to either microphone traversing or airflow across the cable should not introduce cable noise which interferes with the measurements.

5.1.4 Sound level meter or other microphone amplifier. The sound level meter or other amplifier used to amplify the microphone signal shall comply with the electrical requirement for sound level meters of type 1 specified in BS 5969. The flat response shall be used.

5.2 Frequency analyser

The frequency analyser shall have the capacity of measuring one-third octave bandwidths according to BS 2475. The filter band centre frequencies shall be those tabulated in BS 3593.

5.3 Turbulence screens and windshields

5.3.1 Windshields. A microphone exposed to excessive air velocity will give a falsely high reading. This may be rectified by fitting the microphone with a sampling tube, a nose cone, or a foam ball.

In field measurement the foam ball should be used because it reduces the noise generated by a wind from any direction.

In in-duct measurement a nose cone facing the airstream may also be used to reduce wind-generated noise. A sampling tube will in addition reduce the false noise generated by turbulent fluctuations of pressure.

NOTE Calibration certificates provided by the manufacturer of the windshield are acceptable.

5.3.2 Sampling tube. The turbulence screen or sampling tube is a tubular windshield with a longitudinal slit backed by a porous material, and it is attached to the microphone. Its purpose is to reduce the response of the microphone to the turbulent fluctuations of air pressure within the duct. These fluctuations decay rapidly outside the duct, and become negligible in comparison with the acoustically propagated sound at normal listening positions.

The design of a typical sampling tube fitting a 13 mm microphone is shown in Figure 2; suitable tubes are commercially available. The directivity constant K of the microphone-turbulence screen combination is subject to the following limiting values:

One-third octave band, Hz	Minimum limit of K	Maximum limit of K
1 000 to 2 000	0.35×10^{-3}	1.5×10^{-3}
4 000 to 8 000	0.35×10^{-3}	2.2×10^{-3}

NOTE The maximum diameter of the tube should not exceed 22 mm if the flow velocity corrections specified in Table 3(a) and Table 3(b) are to be met.

Table 2 — Example of instrument response correction to measured sound pressure levels

One-third octave centre frequency	Correction C_1	One-third octave centre frequency	Correction C_1
Hz	dB	Hz	dB
50	0	500	0
63	0	1 000	0
80	0	1 250	− 0.1
100	0	1 600	− 0.2
125	0	2 000	− 0.3
160	0	2 500	− 0.2
200	0	3 150	− 0.2
250	0	4 000	− 0.2
315	0	5 000	− 0.2
400	0	6 300	− 0.2
500	0	8 000	− 0.4
630	0	10 000	− 0.5

NOTE The values of C_1 are derived from the curve in Figure 1.

In many cases turbulence levels may be sufficiently low that use of a sampling tube is unnecessary. In these cases a conventional nose cone may be substituted for the microphone protection grid and used for measurements in flow ducts. Protection may be obtained by use of the foam windshield as an alternative to the nose cone.

The sampling tube limits to a greater extent the apparent sound pressure level caused by turbulent pressure fluctuations in the airstream (which are not propagated as noise). These pressure fluctuations are most likely to cause overestimation of fan sound in the frequencies covered by the 63 Hz and 125 Hz octave bands, and the sampling tube is the preferred device when these bands are important.

5.3.3 Acoustic calibration of windshield. The sampling tube, nose cone and foam ball each affect the response of the microphone to a purely acoustical signal. This shall be corrected by adding a correction C_2 dB determined within ± 0.5 dB for each one-third octave band of interest in a plane-wave field appropriately oriented with respect to the microphone-windshield combination. C_2 should be a reasonably smooth function of frequency. If it is determined in a free field, the reference microphone and centre point of the sampling tube, nose cone or foam ball should be placed successively at a point not less than 3 m from the loudspeaker.

NOTE Calibration certificates provided by the manufacturer of the windshield are acceptable.

5.3.4 Wind-generated false noise. The flow of an airstream over a microphone fitted with a sampling tube, nose cone or foam ball will still generate an apparent sound pressure level at the microphone, even though it is reduced when compared with an unshielded microphone. This sound pressure level has to be determined in one-third octave bands of frequency as a function of air velocity and may be neglected if it is 10 dB or more below the sound pressure level measured in a fan test.

If the difference between the sound pressure level measured on test and the airflow generated sound pressure level is less than 10 dB but not less than 5 dB, the test value may be corrected by adding a correction C_5 taken from the following:

Test dB minus wind-generated dB	Correction C_5
More than 10 dB	0 dB
8 dB to 10 dB	– 0.5 dB
6.5 dB to 7.5 dB	– 1.0 dB
5 dB to 6 dB	– 1.5 dB

NOTE A statement provided by the manufacturer of airflow generated sound pressure level spectra is acceptable.

5.3.5 Qualification and correction of the sampling tube. Each sampling tube shall be supplied by the manufacturer with data showing the turbulence noise suppression as a function of air flow velocity at one-third octave band centre frequencies. The turbulence noise suppression is the difference in dB between the corrected microphone responses with a sampling tube and with a nose cone when both are exposed to the same turbulent airstream in the absence of significant sound pressure.

Table 13 is an example for a typical sampling tube. The turbulence noise suppression shall be at least 10 dB in each third octave band of interest. At each test measurement a flow velocity correction C_3 shall be added. The values of the flow correction, C_3 , for the sampling tube shown in Figure 2 are given in Table 3(a) and Table 3(b).

Although the sampling tube suppresses the turbulence noise very substantially, the residual level may still increase the microphone response at low levels of acoustic sound pressure. Appendix B describes a procedure for determining the signal-to-noise ratio for a particular test. The interference will be negligible if this ratio is 6 dB or more.

5.3.6 Modal correction for an in-duct test. Each test measurement made in a duct shall be subject to a modal correction for the determination of mean sound pressure level and sound power level. The correction is a function of the one-third octave band frequency, the ratio of duct diameter to wavelength and the relative radial position of the microphone.

The modal correction C_4 to be added is given in Table 4(a) for a sampling tube for duct diameters up to 2 m, and in Table 4(b) for a nose cone or foam ball. It is derived from the influence of the directivity constant, K , of the microphone/windshield combination. The nose cone and foam ball combinations are treated as omnidirectional.

5.3.7 Overall correction. The overall correction C to be added to the indicated or recorded sound pressure level in a particular test duct at a particular flow velocity will be:

$$C = C_1 + C_2 + C_4 + C_5 \text{ for a nose cone or foam ball,}$$

$$C = C_1 + C_2 + C_3 + C_4 + C_5 \text{ for a sampling tube.}$$

5.4 Graphic level recorder or other read-out devices

The graphic level recorder or other read-out device shall comply with the requirements for type 1 instruments specified in BS 5969.

5.5 Multiplexing system

If a multiplexing system is used, its performance shall be such that the resulting sound pressure level is within ± 0.5 dB of the true energy equivalent average of the individual sound pressure levels.

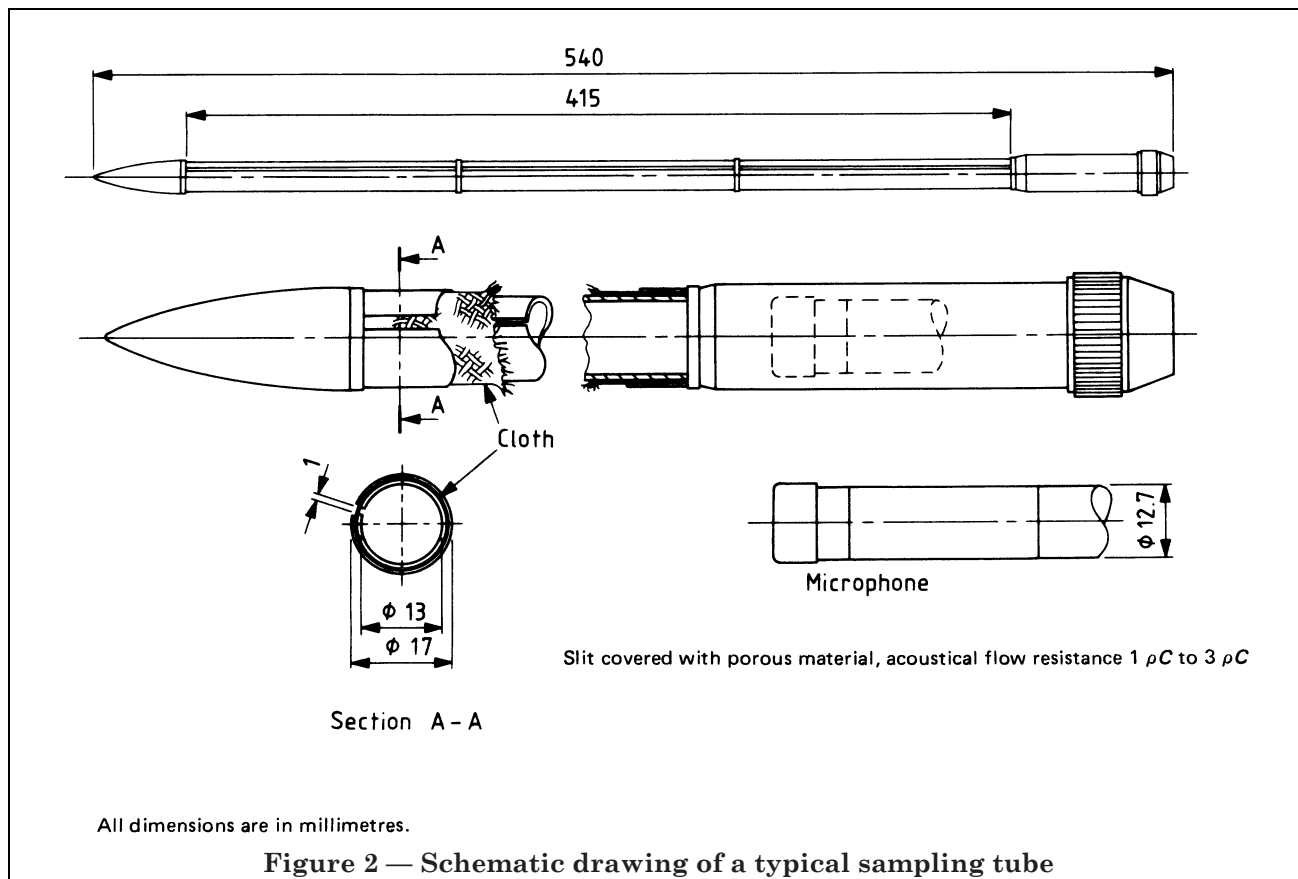


Table 3(a) — Flow velocity correction C_3 for sampling tube in outlet side duct

One-third octave band	Outlet side test with air and sound flow in same direction. Flow velocity range in m/s												
	4 to < 6	6 to < 8	8 to < 10	10 to < 12	12 to < 14	14 to < 16	16 to < 18	18 to < 20	20 to < 22	22 to < 24	24 to < 26	26 to < 28	28 to < 30
Hz	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
1 000	0	0	0	0	0	0	0	0	0	0	0.2	0.2	0.2
1 250	0	0	0	0	0	0	0	0	0.2	0.2	0.2	0.2	0.3
1 600	0	0	0	0	0	0	0.2	0.2	0.2	0.3	0.3	0.3	0.4
2 000	0	0	0	0	0	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5
2 500	0	0	0	0	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8
3 150	0	0	0	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2
4 000	0	0	0.2	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.4	1.6	1.9
5 000	0	0.2	0.3	0.5	0.6	0.8	1.1	1.3	1.6	1.9	2.2	2.6	2.9
6 300	0.2	0.3	0.5	0.7	1.0	1.3	1.7	2.1	2.5	3.0	3.5	4.1	4.6
8 000	0.3	0.5	0.8	1.2	1.6	2.1	2.7	3.4	4.1	4.9	5.7	6.6	7.5
10 000	0.4	0.8	1.2	1.8	2.5	3.3	4.3	5.3	6.4	7.7	8.9	10.1	11.1

Table 3(b) — Flow velocity correction C_3 for sampling tube in inlet side duct

One-third octave band	Inlet side test with air and sound flow in opposite direction. Flow velocity range in m/s												
	4 to < 6	6 to < 8	8 to < 10	10 to < 12	12 to < 14	14 to < 16	16 to < 18	18 to < 20	20 to < 22	22 to < 24	24 to < 26	26 to < 28	28 to < 30
Hz	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
1 000	0	0	0	0	0	0	0	0	0	0	0	0	0
1 250	0	0	0	0	0	0	0	0	0	0	0	0	0
1 600	0	0	0	0	0	0	0	0	0	0.2	0.2	0.3	0.3
2 000	0	0	0	0	0	0	0	0.2	0.2	0.3	0.4	0.4	0.5
2 500	0	0	0	0	0	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9
3 150	0	0	0	0.2	0.2	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.5
4 000	0	0	0.2	0.3	0.4	0.6	0.7	0.9	1.2	1.5	1.8	2.1	2.5
5 000	0	0.2	0.3	0.5	0.7	0.9	1.2	1.5	1.9	2.3	2.8	3.4	4.0
6 300	0	0.3	0.5	0.8	1.1	1.5	2.0	2.5	3.1	3.8	4.6	5.5	6.5
8 000	0.2	0.5	0.8	1.3	1.8	2.5	3.2	4.1	5.2	6.4	7.7	9.0	10.4
10 000	0.4	0.8	1.3	2.0	2.9	3.9	5.2	6.6	8.2	9.9	11.4	12.4	12.6