

Methods of test for

Silencers for air distribution systems

Co-operating organizations

The Heating and Ventilating Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- Association of Consulting Engineers*
- British Refrigeration and Air-Conditioning Association
- British Steel Industry
- Department of the Environment*
- Department of the Environment — Building Research Station*
- Department of Health and Social Security*
- Engineering Equipment Users' Association
- Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales*
- Gas Council*
- Heating and Ventilating Contractors' Association
- Heating and Ventilating Research Association*
- Hevac Association*
- Institute of Fuel
- Institute of Refrigeration
- Institution of Gas Engineers
- Institution of Heating and Ventilating Engineers*
- National Coal Board
- Royal Institute of British Architects
- Royal Society for the Promotion of Health
- British Mechanical Engineering Confederation

The Government departments and scientific and industrial organizations marked with an asterisk in the above list together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- Greater London Council
- Unit Heater Manufacturers' Association

This British Standard, having been approved by the Heating and Ventilating Industry Standards Committee, was published under the authority of the Executive Board on 22 April 1971

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Foreword

This standard makes reference to the following British Standards:

BS 848, *Methods of testing fans for general purposes, including mine fans.*

BS 848-1, *Performance.*

BS 848-2, *Fan noise testing.*

BS 1042, *Methods for the measurement of fluid flow in pipes.*

BS 2475, *Octave and one third octave band-pass filters.*

BS 2750, *Recommendations for field and laboratory measurement of airborne and impact sound transmission in buildings.*

BS 3638, *Method for the measurement of sound absorption coefficients (ISO) in a reverberation room.*

BS 4196, *Guide to the selection of methods of measuring noise emitted by machinery.*

BS 4197, *A precision sound level meter.*

This British Standard has been prepared under the authority of the Heating and Ventilating Industry Standards Committee in response to requests from the industry.

The Committee acknowledges its indebtedness to the work of the Heating and Ventilating Research Association on “The measurement of the performance of unit silencers” (Report No. 55:1969). The principles laid down in that report have been embodied in this British Standard. The acoustic performance of a silencer, used in ventilating and air conditioning systems, is expressed in terms of:

- 1) its insertion loss; this is the reduction in the rate of flow of sound energy (sound power) after a silencer arising solely from the insertion of the silencer into the system;
- 2) its airflow generated noise; a silencer presenting obstructions to straight-through flow will generate more noise than an ordinary straight duct. In high velocity systems or critical noise control applications this “serf noise” of the silencer may limit the amount of attenuation it can provide;
- 3) its pressure loss; this is a measure of the pressure required to pass air through the silencer.

The precise requirements of this British Standard, as to dimensions and layout of the test facility, are necessary to ensure a good degree of repeatability in test results between those on one silencer tested at different laboratories or even between those on one silencer tested at different times in the same laboratory. The dimensions and layout of the test installation are unlikely to be found in practical air distribution systems and, consequently, the performance of silencers in situ may vary from the test results; in most cases the variations are small and can be minimized especially for generated noise by good standards of duct manufacture, layout and design.

The Appendix E and Appendix F offer guidance on:

- 1) the extrapolation from the results of tests carried out in accordance with this British Standard on a particular silencer, to estimate the performance of similar silencers of different size;
- 2) the measurement of casing radiation.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 22, 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 General

1.1 Scope

This British Standard deals with the objective measurement and determination of the performance of unit silencers and silencing elements for ducted ventilating and air conditioning systems. It considers three aspects of the performance of a silencer:

- 1) The attenuation of broad band airborne sound (insertion loss).

NOTE The test methods specified in this standard measure insertion loss without airflow. It may be that these methods do not give accurate insertion loss data for applications where the air velocity between silencing elements is in excess of about 20 m/s. Significant variation of insertion loss with velocity may occur at higher velocities and hence insertion loss data obtained by the methods recommended in this standard should be interpreted with caution if the air velocity within the silencer is in excess of 20 m/s.

- 2) The generation of aerodynamic noise by air flowing through the silencer (generated noise level).
- 3) The change in pressure of air flowing through the silencer. This may be expressed as a static pressure loss or a total pressure loss. It is normal practice in assessing the pressure loss of an air distribution system to consider the total pressure loss of the components forming that system. The silencer is rated in terms of total pressure.

This British Standard should not be used to determine the performance of silencers providing selective attenuation over narrow frequency bands (i.e. less than 1/3 octave).

The results obtained from tests carried out using the standard should not be used to determine the performance of:

- 1) Silencers which are designed for direct coupling to a fan. Such combinations are considered as a single unit and the performance in terms of inlet or outlet sound power levels should be obtained by one of the methods recommended in BS 848-2¹⁾.
- 2) Silencers designed to be installed to increase the sound insulation of a partition having a ventilation opening. The sound insulation provided by such silencers can be assessed by tests carried out in accordance with BS 2750²⁾.

1.2 General

1.2.1 For the purposes of this British Standard the term silencer is used to describe either a unit silencer or an arrangement of silencing elements.

Silencers may be divided into two classes:

- Type A:* Silencers having the same dimensions and direction for the inlet and outlet connections.
- Type B:* Silencers having different dimensions and/or different directions for the inlet and outlet connections.

1.2.2 Mean band sound pressure levels shall be calculated as in Appendix A.

1.2.3 The end reflection shall be calculated as in Appendix B.

¹⁾ BS 848, "Methods of testing fans for general purposes, including mine fans", Part 2, "Fan noise testing".

²⁾ BS 2750, "Recommendations for field and laboratory measurement of airborne and impact sound transmission in buildings".

1.3 Definitions

For the purposes of this British Standard the following definitions apply:

1.3.1 unit silencer

a device to carry air as part of an air distribution system to provide an attenuation of sound

1.3.2 silencing element

an element designed to be introduced within a passage-way in an air distribution system to provide an attenuation of sound

1.3.3 insertion loss

the difference between the output sound power levels of the system before and after insertion of the silencer

1.3.4 generated noise level

the sound power level that is radiated through either the inlet or outlet duct connection of a silencer and which arises from airflow within the silencer

1.3.5 total pressure loss

the difference between the mean total pressure at the silencer inlet and the mean total pressure at the silencer outlet. The pressure loss is specified for air of standard density, 1.2 kg/m^3

1.3.6 silencer-in test

test carried out with the unit silencer inserted into the test installation

1.3.7 silencer-out test

test carried out with a plain substitution duct replacing the unit silencer in the test installation

1.3.8 silencer face velocity

the mean air velocity at the silencer inlet connection

1.3.9 silencer airway velocity

the mean air velocity, at the minimum airway section, between silencing elements

1.4 Symbols

The following general symbols are used in this standard:

Symbol	Quantity	Unit
P	Sound pressure	N/m^2
P_0	Reference sound pressure	$2 \times 10^{-5} \text{ N/m}^2$
L_p	Sound pressure level $= 20 \log_{10} \frac{P}{P_0}$	dB
W	Sound power	W
W_0	Reference sound power	10^{-12} W
L_w	Sound power level $= 10 \log_{10} \frac{W}{W_0}$	dB
X_r	End reflection factor	dB
IL	Insertion loss	dB
ΔP	Pressure loss	N/m^2
D	Duct size = diameter (circular duct) or major dimension of rectangular duct	m
D_H	Duct hydraulic diameter $= \frac{4 \times \text{cross-sectional area}}{\text{perimeter}}$	m
$\bar{P}_v$	Velocity pressure corresponding to average duct velocity $= \frac{1}{2} \rho \bar{v}^2$	N/m^2
$\bar{v}$	Average velocity in test duct	m/s
Q	Volume flow rate in test duct	m^3/s
ρ	Air density	kg/m^3
t	Air temperature	$^{\circ}\text{C}$

1.5 Instrumentation

1.5.1 Acoustic instrumentation

1.5.1.1 Measuring equipment. Sound measuring equipment which complies with BS 4197³⁾ shall be used. An extension cable shall be available to separate the microphone from the instrument cases and the observers.

The filters shall comply with BS 2475⁴⁾.

The use of high speed level recorder or similar automatic recording apparatus is permitted provided that the overall performance of the complete equipment meets the requirements of BS 4197.

1.5.1.2 Calibration. The acoustical performance of the sound analysis equipment shall be checked, and any specified adjustments made, immediately before each series of noise measurements and rechecked immediately after each series.

The measuring equipment should be tested periodically for compliance with BS 4197³⁾ at a laboratory equipped with the necessary calibration facilities.

A random incidence calibration shall be employed for generated noise level tests.

³⁾ BS 4197, "A precision sound level meter".

⁴⁾ BS 2475, "Octave and one third octave band-pass filters".