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**METHODS FOR
TESTING AND RATING
AIR TERMINAL DEVICES
FOR AIR DISTRIBUTION
SYSTEMS**

Part 1. Aerodynamic testing

**BRITISH STANDARDS INSTITUTION
Gr. 8**

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Part 1. Performance.
- BS 1042. Methods for the measurement of fluid flow in pipes.
Part 1. Orifice plates, nozzles and venturi tubes.
Part 2. Pitot-tubes.

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The following BSI references relate to the work on this standard:
Committee reference RHE/2 Draft for comment 70/25130

CONTENTS

	Page
Co-operating organizations	5
Foreword	6

METHODS**1. GENERAL**

1.1 Scope	6
1.2 Definitions	7
1.3 Nomenclature	18

2. INSTRUMENTATION

2.1 Volume flow rate measurement	20
2.2 Manometers	20
2.3 Velocity measurement	20
2.4 Pressure measurement	21
2.5 Temperature measurement	21

3. TESTING FOR PRESSURE LOSS

3.1 The measurement of total pressure loss of a supply air terminal device	21
3.2 The measurement of total pressure loss of a return air terminal device	24
3.3 The measurement of total pressure loss of a transfer grille	27

4. TESTS TO MEASURE THE ENVELOPE PARAMETERS

4.1 The test room	29
4.2 Test room equipment and instrumentation	30
4.3 Installation of the air terminal device	31
4.4 Test procedure	32
4.5 Analysis of test results	35

5. RATING

5.1 Requirements	36
5.2 Correlation of test results	39

6. VARIATIONS IN TEST PROCEDURE

6.1 Non-isothermal testing	43
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	Page
7. EXTRAPOLATION AND ACCURACY	
7.1 Extrapolation	45
7.2 Accuracy	45

APPENDIX

A. Typical low speed calibration apparatus	46
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TABLES

1. Typical test room dimensions	30
2. Vertical traverse interval	33
3. Standard test sizes	39

FIGURES

1. Types of damper	10
2. Supply of air with a temperature equal to the room air temperature	14
3. Supply of air with a temperature colder or warmer than the room air temperature	15
4. Air supply from a ceiling-mounted air terminal device	16
5. Air supply from an air terminal device where the diffusion distribution is circular	16
6. Air supply from an air terminal device with vertical direction of the air jet	17
7. Nomenclature	19
8. Air terminal devices—pressure loss (supply)—typical test arrangement	22
9. Air terminal devices—pressure loss (return)—typical test arrangement	25
10. Air terminal devices—pressure loss (transfer)—typical test arrangement	28
11. Determination of Z_m from transverse velocity profile	34
12. Determination of throw	37
13. Determination of maximum spread	38
14. Total pressure loss coefficient	41
15. Throw correlation	42
16. Spread to throw ratio	44
17. Section through calibration tunnel	49
18. Entry and nozzle contours	50
19. Example of calibration curve	51

CO-OPERATING ORGANIZATIONS

The Refrigeration, Heating and Air Conditioning 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
- Association of Manufacturers of Domestic Electrical Appliances
- Boiler and Radiator Manufacturers' Association Limited
- British Mechanical Engineering Confederation
- British Oil and Gas Firing Equipment Manufacturers' Association
- British Refrigeration and Air Conditioning Association
- *Department of the Environment
- *Department of Health and Social Security
- Electricity Council, The Central Electricity Generating Board and the Area Boards in England and Wales
- Engineering Equipment Users' Association
- *Gas Council
- Heating and Ventilating Contractors' Association
- *Heating and Ventilating Research Association
- *HEVAC Association
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- Institute of Refrigeration
- Lloyd's Register of Shipping
- Ministry of Defence (Navy)
- National Coal Board
- Royal Institute of British Architects
- Water-tube Boiler Makers Association

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:

Department of the Environment (Building Research Station)
Greater London Council
Unit Heater Manufacturers' Association



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BRITISH STANDARD METHODS FOR TESTING AND RATING AIR TERMINAL DEVICES FOR AIR DISTRIBUTION SYSTEMS

Part 1. Aerodynamic testing

FOREWORD

This Part of this British Standard has been prepared under the authority of the Refrigeration, Heating and Air Conditioning Industry Standards Committee in response to requests from industry. It forms Part 1 of a British Standard for testing and rating air terminal devices which, it is envisaged, will later contain a second part dealing with acoustic testing, in addition to Part 1, 'Aerodynamic testing'.

The Committee acknowledge that they are indebted to the Heating and Ventilating Research Association for their work of devising suitable test methods for incorporation into this British Standard. This research and development was carried out under a Department of Trade and Industry contract.

The Committee also acknowledge the value of the work carried out, under the auspices of the EUROVENT organization, to standardize and to define terms in common use in air diffusion throughout Europe. These terms have the additional virtue of being readily translatable into the French and German languages.

Air diffusion is defined as the distribution of the air in a space, called the treated space, by means of devices called air terminal devices, in a manner to satisfy certain specified conditions such as air change rate, pressure, cleanliness, temperature, humidity, air velocity and noise level, in a determined zone within this space which is called the occupied zone.

Air terminal devices form the common boundaries between the treated space and the air distribution system.

NOTE. For normal applications in human comfort environment the occupied zone is geometrically limited at 0.15 m from all room surfaces with a height of 1.80 m above the floor. For other environmental conditions the boundaries of the occupied zone should be specified.

For the purpose of this document air distribution is defined as the transportation of a specified air flow to or from the treated space or spaces, generally by means of ducts.

METHODS

1. GENERAL

1.1 SCOPE

This Part of this British Standard deals with all types of elements of air diffusion, such as grilles, registers, diffusers, etc. Elements concerned with air distribution are not considered.

The aerodynamic characteristics of air terminal devices can be specified by two basic parameters: the total pressure loss caused by the insertion of the device at the termination of a duct and, for supply devices, the envelope of the jet issuing from the device. The former parameter can be measured fairly easily and accurately, although some difficulty can be experienced with the low losses of large units. Where pressure losses are too low to measure accurately extrapolations are permitted, the accuracy of the experimental data in such circumstances being less important.

NOTE. The titles of the British Standards referred to in this standard are listed on page 2.

1.2 DEFINITIONS

For the purposes of this British Standard the following definitions apply. Basic terms which are generally applicable to air distribution systems are set out in

1.2.1. Terms relating to the main categories of components in air diffusion are given in **1.2.2** to **1.2.4**. **1.2.5** gives terms relating to air terminal devices.

1.2.1 Supply and exhaust

1.2.1.1 Supply. The air flow entering the treated space.

1.2.1.2 Exhaust. The air flow leaving the treated space. Exhaust may take one or more of the following forms.

- (1) *Extract.* Exhaust in which the air is discharged to atmosphere.
- (2) *Relief.* Exhaust in which air is allowed to escape from the treated space should the pressure in the space rise above a specified level.
- (3) *Re-circulation.* Exhaust in which the air is returned to the air treatment system.
- (4) *Transfer.* Exhaust in which air passes from the treated space to another treated space.

1.2.2 Air terminal device. A component of the installation which is designed to ensure the predetermined movement of air into or from a treated space (e.g. grille, diffuser, etc.). It is associated with an air distribution system, located in an opening provided at the boundaries of the treated space.

1.2.2.1 Supply air terminal device. An air terminal device through which air enters a treated space. It usually consists of a deflecting member or members which ensure a reduction of the air velocity in the zone between the air terminal device and the occupied zone and efficient mixing of the supply air with the air of the treated space.

Supply air terminal devices usually also determine the direction of the air jet or jets.

1.2.2.2 Exhaust air terminal device. An air terminal device through which air leaves the treated space.

1.2.2.3 Air diffuser. A supply air terminal device usually placed in the ceiling and generally circular, square or rectangular in form, and composed of divergent deflecting members.

(1) *Fully adjustable air diffuser.* An air diffuser which incorporates two independent integral devices, each of them achieving one of the following purposes:

a. the variation of the direction of the air jets without alteration of the air flow rate;

b. the variation of the primary air flow rate without alteration of the direction of the air jets.

(2) *Adjustable pattern air diffuser.* An air diffuser which incorporates an integral device by means of which the direction of the air jets can be varied.

NOTE. Variation of the direction of the air jets results, however, in a change in the pressure requirements of the diffuser which may necessitate adjustment within the air distribution system.

(3) *Adjustable flow rate air diffuser.* An air diffuser which incorporates a device by means of which the primary air flow rate can be varied without affecting the direction of the air jets.

1.2.2.4 Slot air terminal device. A device with single or multiple components, with an aspect ratio of 10 : 1 or greater for each slot (the aspect ratio is the ratio of length and width of the enclosed rectangular opening).

A slot may or may not have an adjustable member to vary the direction of the air jet or jets or air flow rate.

1.2.2.5 Grille. An air terminal device with multiple passages for the air, but without a damper.

(1) *Fixed non-directional grille.* An air terminal device with fixed laminae or ribs. It is not intended to change the direction of the air (e.g. perforated metal grid, wire grid, etc.).

(2) *Fixed directional grille.* An air terminal device with fixed laminae which will diffuse the air in one or more directions.

(3) *Adjustable grille.* An air terminal device with adjustable laminae or blades which by adjustment can vary the direction of the discharged air. The laminae are normally either vertical, horizontal, or both vertical and horizontal.

(4) *Register.* A combined grille and damper assembly (see 1.2.3.1).

1.2.2.6 Lighting troffer air terminal device. An air terminal device, usually in the form of a slot or a combination of slots, for use with a lighting troffer unit.

1.2.2.7 Linear air terminal device. An air terminal device with multiple passages contained within a rectangular frame having an aspect ratio of 5 : 1 or greater.

1.2.2.8 Nozzle. An air terminal device so designed as to give low energy loss and thus to produce a maximum throw with minimum entrainment.

NOTE. See 1.2.5.5.12.

1.2.3 Complementary accessories to air terminal devices. Components of the installation which are used in conjunction with, and which form an integral part of, air terminal devices to ensure the predetermined profile or rate of airflow into or from the air terminal device (e.g. equalizing grids, dampers, etc.).

1.2.3.1 Air flow rate controllers. Components known as dampers which change the air flow rate by modifying the resistance. The various types are described below and in Fig. 1.

Single leaf damper	with central mounting the flap being mounted at one end	Fig. 1a Fig. 1b
Butterfly damper	with two flaps in 'V' arrangement	Fig. 1c
Multiple leaf damper	having a number of shutters of opposed blade or parallel leaf type	Fig. 1d
Iris damper (sectorized shutters)		Fig. 1e
Hit and miss damper	having two or more slotted slides in parallel arrangement and adjustable against each other	Fig. 1f
Slide damper	the sliding part of which is perpendicular to the direction of the air flow	Fig. 1g

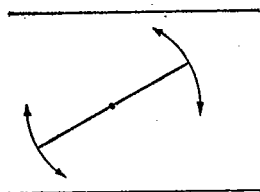


Fig. 1a. Single leaf damper

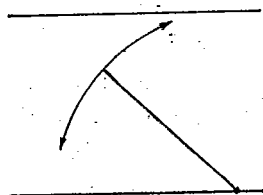


Fig. 1b. Single leaf damper

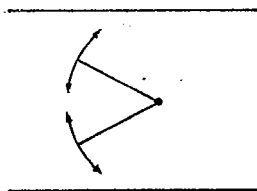


Fig. 1c. Butterfly damper

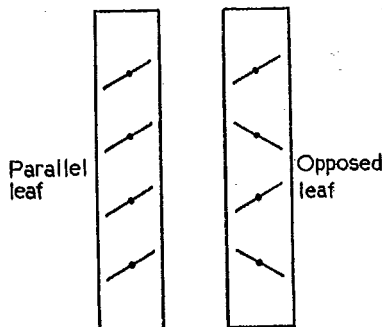


Fig. 1d. Multiple leaf damper

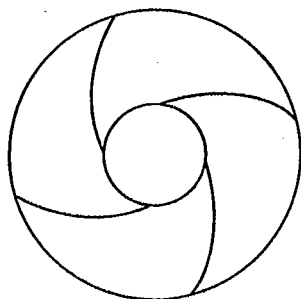


Fig. 1e. Iris damper



Fig. 1g. Slide damper

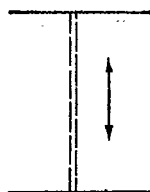


Fig. 1f. Hit and miss damper

Fig. 1. Types of damper

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1.2.3.2 Flow equalizers. Components, such as turning vanes, straightening elements, perforated plates, screens, etc., which, used as part of air terminal devices, even out the air velocity and/or decrease the relative magnitude of fluctuations characteristic of the air flow.

1.2.3.3 Baffle. A device used for partial blanking of the air flow through an air terminal device, generally consisting of a plate or series of plates.

For instance, a sectorizing baffle is a plate or plates fitted inside a circular diffuser with the purpose of preventing the discharge of air from certain radial directions of the diffuser.

Another example is the blanking plate or plates which prevent the discharge of air from certain parts of a grille or rectangular diffuser.

1.2.4 Fixing accessories for air terminal devices. Components of the installation which assist the fitting and fixing into place of the air terminal devices and complementary accessories of air terminal devices and their maintenance (e.g. plaster frames, snap-in fasteners, etc.).

1.2.5 Terms relating to air terminal devices

1.2.5.1 Nominal size of an air terminal device. The nominal value of dimensions of the prepared opening into which the air terminal device is to be fitted.

NOTE. For an air diffuser the nominal size is generally known as the neck size.

1.2.5.2 Core and specific areas

1.2.5.2.1 Core of an air terminal device. That part of an air terminal device located within a convex closed surface of minimum area inside of which are openings of the air terminal device through which the air can pass.

1.2.5.2.2 Effective area (of an air terminal device). The smallest area of an air terminal device utilized by the airstream in passing through the air terminal device. This does not necessarily coincide with the free area or core area of an air terminal device.

1.2.5.2.3 Free area (of an air terminal device). The sum of the minimum measured areas of each opening through which the air can pass.

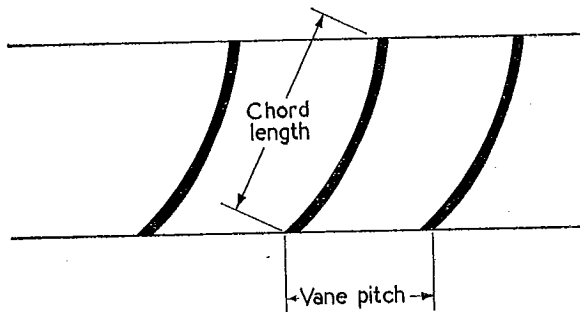
1.2.5.2.4 Free area ratio (of an air terminal device). The ratio of the free area to the core area.

1.2.5.2.5 A_K value (of an air terminal device). The quotient resulting from the measured air flow rate and measured air velocity as determined in a specified manner with a specified instrument.

1.2.5.3 Aspect and vane ratios

1.2.5.3.1 Aspect ratio (of a rectangular air terminal device). The ratio of the larger side to the smaller side of the rectangular core.

1.2.5.3.2 Vane ratio (of a grille). The ratio of the chord length to the vane pitch.



1.2.5.4 Terms relating to air

1.2.5.4.1 Standard air. Atmospheric air having a density of 1.2 kg/m^3 at 20°C , $101\,325 \text{ N/m}^2$ (1013.25 mbar) and 65 % relative humidity.

1.2.5.4.2 Supply air. The air entering a supply air terminal device from an upstream duct.

1.2.5.4.3 Induced air. Air flow from the treated space induced by the supply air from a supply air terminal device.

1.2.5.4.4 Exhaust air. The air leaving an exhaust air terminal device.

1.2.5.5 Specific terms relating to air diffusion rating. The definitions given in 1.2.5.5.12 to 1.2.5.5.15 are illustrated in Figs. 2 to 6.

1.2.5.5.1 Supply temperature differential. The algebraic difference between the supply air temperature and the mean measured air temperature of the occupied zone.

1.2.5.5.2 Exhaust temperature differential. The algebraic difference between the exhaust air temperature and the mean measured air temperature of the occupied zone.

1.2.5.5.3 Measured mean air temperature of the occupied zone. The arithmetical average of the measured values of air temperature within the occupied zone.

1.2.5.5.4 Temperature difference within the occupied zone. The largest value of the difference between measured air temperatures within the occupied zone.

1.2.5.5.5 Supply air volume flow rate. The volume of air entering a supply air terminal device in unit time.

1.2.5.5.6 Exhaust air volume flow rate. The volume of air leaving an exhaust air terminal device in unit time.

1.2.5.5.7 Local air velocity. The magnitude of the time-averaged vector of velocity in a point of an air stream.

1.2.5.5.8 Local measured air velocity. The measured value of local air velocity.

NOTE. The velocity vector (and therefore its three mutually perpendicular components u , v , w) in any point of a turbulent stream is submitted to fluctuations with respect to time (t). The time-averaged vector of velocity is a vector for which each component is averaged with respect to time, the components being:

$$\bar{u} = \frac{1}{r} \int_0^r u \, dt; \quad \bar{v} = \frac{1}{r} \int_0^r v \, dt; \quad \bar{w} = \frac{1}{r} \int_0^r w \, dt;$$

the local air velocity is therefore $\sqrt{(\bar{u})^2 + (\bar{v})^2 + (\bar{w})^2}$

1.2.5.5.9 Envelope. The geometrical surface in a treated space where the local measured air velocity has the same specified value.

1.2.5.5.10 Room velocity. The value of velocity conventionally derived from the various local measured air velocities within the occupied zone.

1.2.5.5.11 Free area velocity. Supply air volume flow rate divided by the free area of a supply air terminal device, or exhaust air volume flow rate, divided by the free area of an exhaust air terminal device.

1.2.5.5.12 Throw (for a supply air terminal device). The distance between the centre of the core and a plane which is tangential to a specified envelope and perpendicular to the intended direction of flow.

(1) *Radius of diffusion.* The throw of a diffuser having a circular projection of up to 360° in a single plane.

1.2.5.5.13 Drop (for a supply air terminal device). The vertical distance between the lowest horizontal plane tangential to a specified envelope and the centre of the core.

1.2.5.5.14 Rise (for a supply air terminal device). The vertical distance between the highest horizontal plane tangential to a specified envelope and the centre of the core.

1.2.5.5.15 Spread (for a supply air terminal device). The maximum distance between two vertical planes tangential to a specified envelope and perpendicular to a plane through the centre line of the core.

The spread need not necessarily be symmetrical about the plane perpendicular to the centre line of the core.

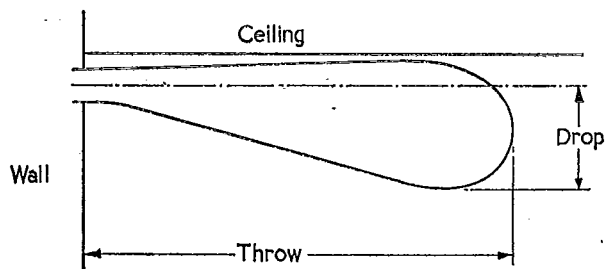


Fig. 2a. Side view

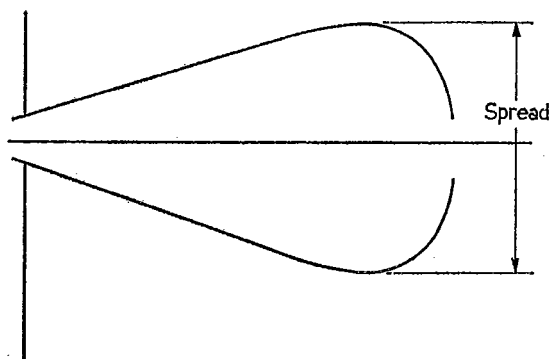


Fig. 2b. View from above

Fig. 2. Supply of air with a temperature equal to the room air temperature

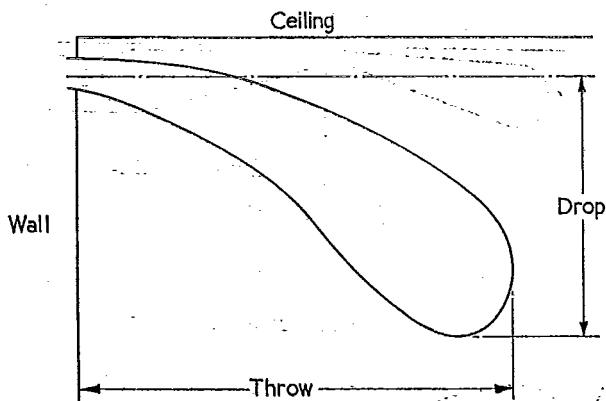


Fig. 3a. Cold air

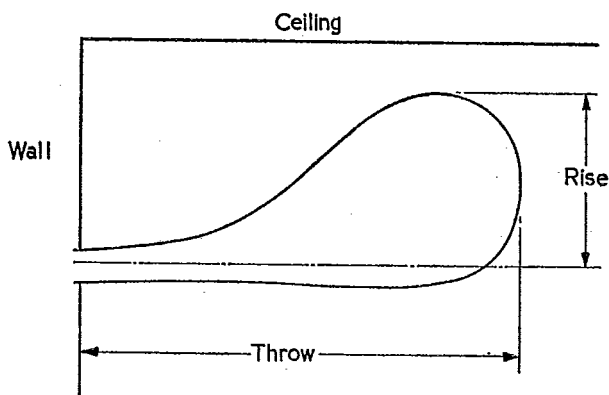


Fig. 3b. Warm air

Fig. 3. Supply of air with a temperature colder (a) or warmer (b) than the room air temperature