

Methods for

Testing and rating air terminal devices for air distribution systems —

Part 1: Aerodynamic testing —

Section 1.1 Testing under laboratory
conditions

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refrigeration, Heating and Air Conditioning Standards Policy Committee (RHE/-) to Technical Committee RHE/2, upon which the following bodies were represented:

- Association of Consulting Engineers
- Chartered Institution of Building Services Engineers
- Department of Health
- Department of the Environment (Property Services Agency)
- Department of the Environment (Building Research Establishment)
- Heating and Ventilating Contractors' Association
- Heating, Ventilating and Air Conditioning Association
- Hevac Association
- Society of British Gas Industries

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Foreword

This Part of this British Standard has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee to provide methods for the aerodynamic testing of air terminal devices used in air distribution systems. It supersedes BS 4773-1:1971, which is withdrawn.

The specified tests are for the determination of:

- a) pressure/flow rate characteristics;
- b) area factor;
- c) air discharge characteristics under isothermal conditions and in the cooling mode.

Other Sections of the standard in the course of preparation will cover:

- *Section 1.2: Laboratory methods of measuring conditions in the occupied zone;*
- *Section 1.3: Performance rating in relation to comfort criteria.*

Part 2 of this standard covers acoustic testing.

In preparing this revision of Part 1 due regard has been taken of the International Standard ISO 5219 on laboratory aerodynamic testing and rating of air terminal devices.

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 and ii, pages 1 to 28, 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 Section of BS 4773-1 describes methods for the laboratory aerodynamic testing of air terminal devices and the assessment of their performance over a range of operating conditions.

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 British Standard, the following definitions apply.

2.1

treated space

an enclosure served by an air distribution system

2.2

occupied zone

a portion of the treated space in general occupation geometrically limited to no closer than 0.15 m to all walls and within a height of 1.8 m above the floor

2.3

supply

the air flow entering the treated space

2.4

exhaust

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

- a) *extract*. Exhaust in which the air is discharged to atmosphere.
- b) *relief*. Exhaust in which the air is allowed to escape from the treated space should the pressure in the space rise above a specified level.
- c) *recirculation*. Exhaust in which the air is returned to the air treatment system.
- d) *transfer*. Exhaust in which air passes from the treated space to another treated space.

2.5

air terminal device

a component of the installation that 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 and located in an opening provided at the boundaries of the treated space

2.6

supply air terminal device

an air terminal device through which air enters a treated space. It usually consists of a deflecting member or members that impart specific direction(s) to the air stream (jet) entering the treated space and ensure efficient mixing of the supply air with the air of the treated space

2.7

exhaust air terminal device

an air terminal device through which air leaves the treated space

2.8

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

2.9

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 being 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(s) or air flow rate

2.10

grille

an air terminal device with multiple passages for air, but without a damper

2.11

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

2.12

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 2.20.

2.13

flow equalizers

components, such as turning vanes, straightening elements, perforated plates, screens etc., which, used as part of an air terminal device, even out the air velocity and/or decrease the relative magnitude of fluctuations characteristic of the air flow

2.14

core

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

2.15

nominal size

the recommended dimensions of the prepared opening into which the air terminal device is to be fitted

2.16

standard air

atmospheric air having a density of 1.2 kg/m³ at 20 °C, 101 325 N/m² (1013.25 mbar) and 65 % r.h.

2.17

supply air

the air entering a supply air terminal device from an upstream duct

2.18

exhaust air

the air leaving an exhaust air terminal device

2.19

envelope

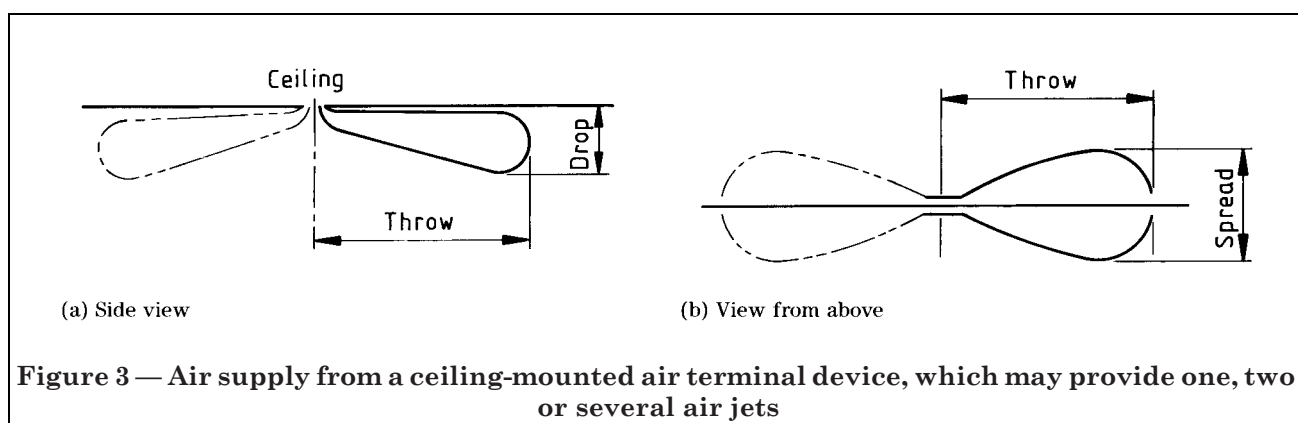
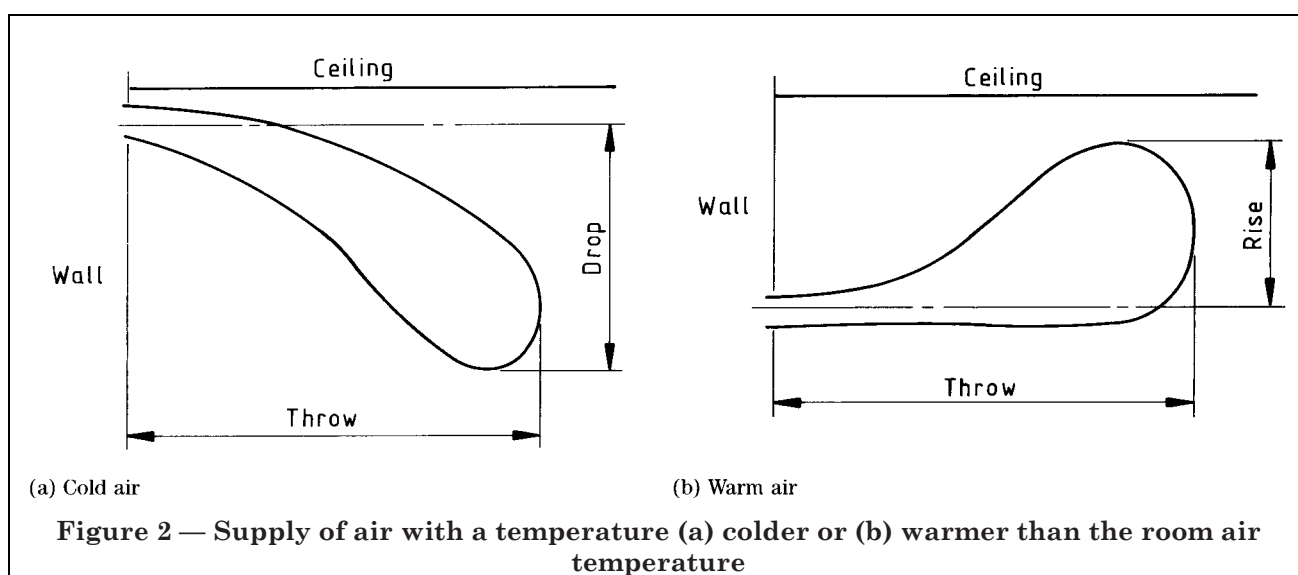
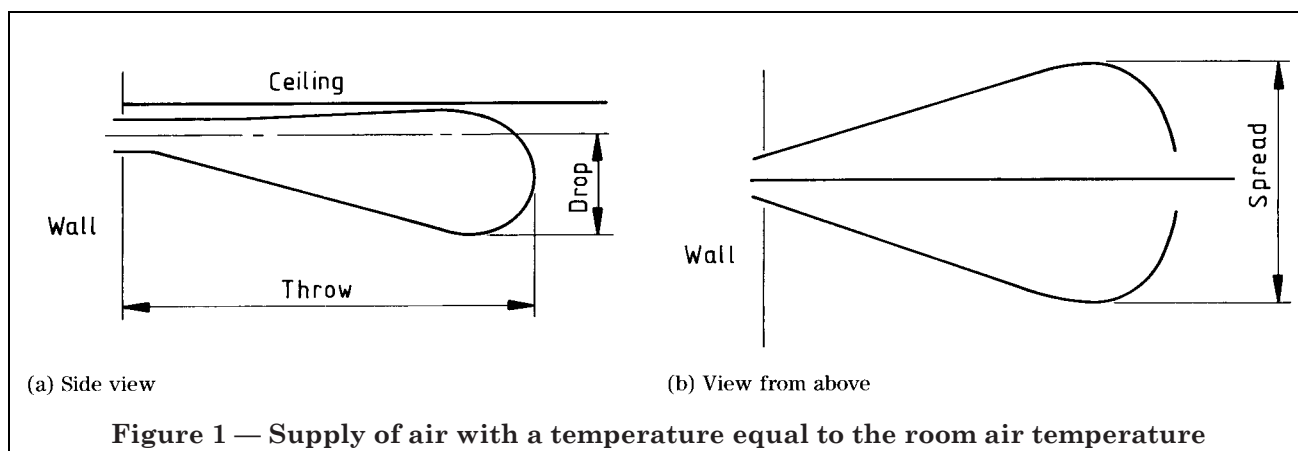
the geometrical surface in an air stream where the local measured air velocity has the same specified value

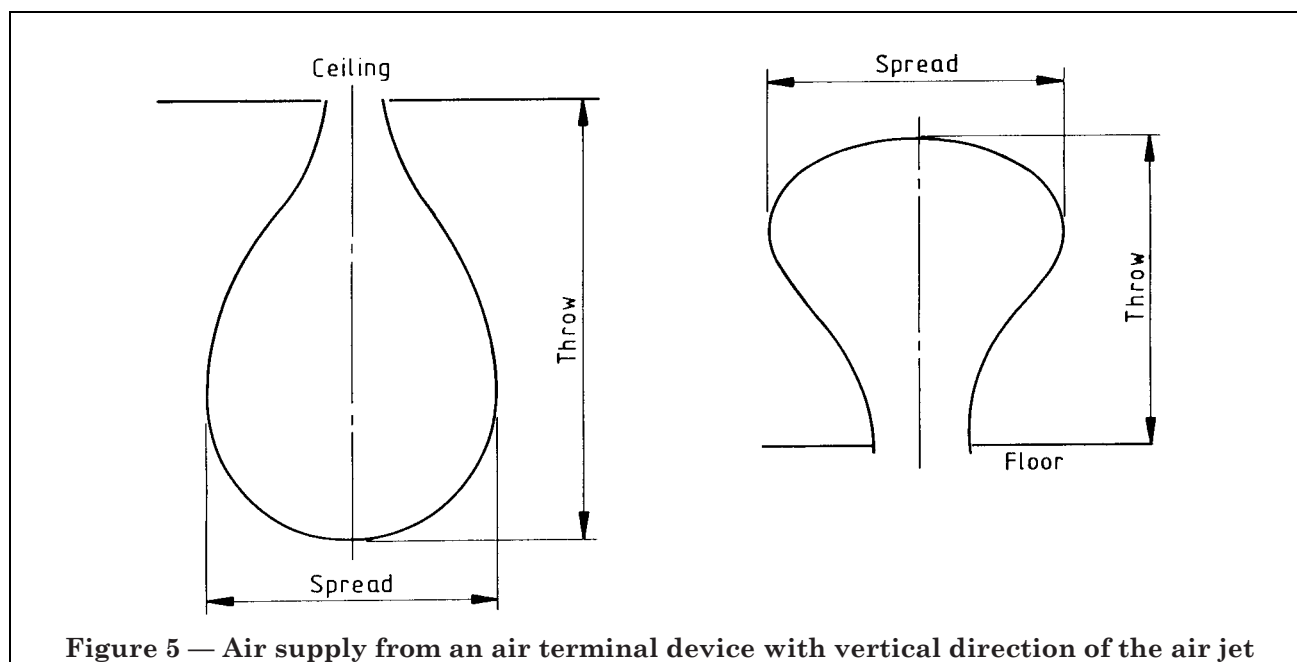
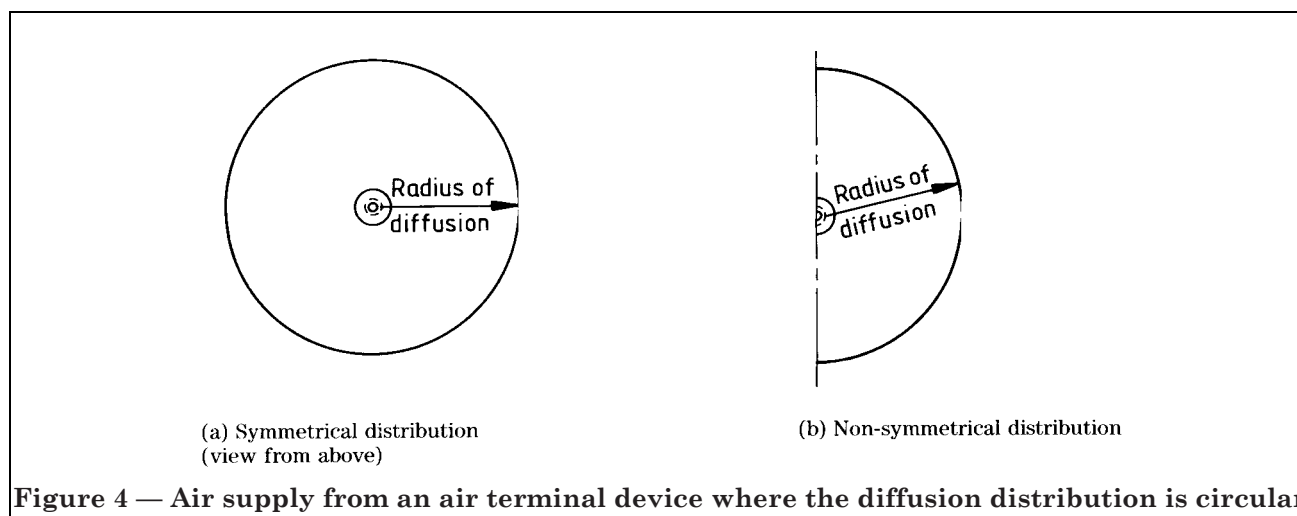
2.20

throw (for a supply air terminal device)

the distance between the centre of the core and a plane that is tangential to a specified envelope and perpendicular to the intended direction of flow (See Figure 1 to Figure 5.)

for radial air projection the throw is known as the radius of diffusion (See Figure 4.)





2.21

drop (for a supply air terminal device)

the vertical distance between the centre of the core and the lowest horizontal plane tangential to a specified envelope (See Figure 1 to Figure 3.)

2.22

rise (for a supply air terminal device)

the vertical distance between the centre of the core and the highest horizontal plane tangential to a specified envelope (See Figure 2.)

2.23

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 (See Figure 1, Figure 3 and Figure 5.)

2.24**isothermal**

the test condition in which the supply and exhaust air temperatures are at substantially the same value

2.25**non-isothermal**

the test condition in which the supply and exhaust air temperatures are at substantially different values. In the cooling mode, the supply air temperature is lower than the exhaust air temperature

3 Symbols and suffixes**3.1 Symbols**

The following nomenclature is used throughout this standard:

Symbol	Quantity	Corresponding SI unit	Dimensions
a, b	Dimensions of rectangular duct cross section	m	L
A_d	Area corresponding to the nominal size of the duct to which the device is fitted	m ²	L^2
A_f	Free area of air terminal device	m ²	L^2
A_n	Neck area of circular or square diffuser	m ²	L^2
A_k	k factor area $\left(\frac{q_v}{v_k}\right)$	m ²	L^2
b_R	Width of test room	m	L
D	Duct diameter	m	L
D_e	Equivalent diameter $\left(\sqrt{\frac{4 \times A_d}{\pi}}\right)$	m	L
D_h	Hydraulic diameter $\left(\frac{4 \times A_d}{\text{perimeter}}\right)$	m	L
H	Height of air terminal device mounting plate	m	L
h_R	Height of test room	m	L
L	Distance between air terminal device and plane of pressure measurement in test duct	m	L
l	Distance of pitot-static tube location from centre of rectangular duct	m	L
l_R	Length of test room	m	L
n	Length of linear grille or diffuser	m	L
p	Absolute static pressure	Pa	$ML^{-1}T^{-2}$
p_a	Atmospheric pressure	Pa	$ML^{-1}T^{-2}$
p_d	Velocity pressure $\left(\rho \frac{v^2}{2}\right)$	Pa	$ML^{-1}T^{-2}$
p_s	Static gauge pressure $(p - p_a)$	Pa	$ML^{-1}T^{-2}$
p_r	Stagnation (or absolute total) pressure	Pa	$ML^{-1}T^{-2}$
p_t	Total pressure $(p_r - p_a)$	Pa	$ML^{-1}T^{-2}$
Δp_s	Static gauge pressure difference	Pa	$ML^{-1}T^{-2}$
q_v	Volume rate of flow	m ³ /s	L^3T^{-1}
R	Area parameter that relates to effective size of device under test	m ²	L^2
r	Radius of pitot-static tube locations in circular duct	m	L

Symbol	Quantity	Corresponding SI unit	Dimensions
S	Linear parameter that relates to effective size of device under test	m	L
v	Velocity	m/s	LT^{-1}
v_k	k factor velocity $\left(\frac{q_v}{A_k}\right)$	m/s	LT^{-1}
v_x	Maximum velocity at distance x from centre of supply air terminal device	m/s	LT^{-1}
W	Width of air terminal device mounting plate	m	L
X	Throw	m	L
X_c	Axis of velocity measurement in direction of throw	m	L
x	Distance from centre of supply air terminal device in direction of throw	m	L
Y	Spread	m	L
Y_c	Axis of velocity measurement in direction of spread	m	L
Z	Drop (or rise)	m	L
Z_c	Axis of velocity measurement in direction of drop/rise	m	L
ζ	Loss coefficient	—	dimensionless number
θ	Thermodynamic temperature	K	θ
ρ	Density	kg/m ³	ML^{-3}

3.2 Suffixes

The suffixes used in this British Standard are as follows.

- a) D Value corrected to take account of test duct pressure loss
- b) m Mean value
- c) u Refers to flow measuring station
- d) 1 Refers to measuring position in test duct

4 Instrumentation

4.1 Volume flow rate measurement

4.1.1 Accuracies

Air flow meters shall have accuracies at least as precise as those shown in Table 1.

Table 1 — Minimum accuracies for flow meters

Flow rate range	Accuracy of measurement
Below 0.007 m ³ /s	± 0.0009 m ³ /s
0.007 to 0.07 m ³ /s	± 5 %
Above 0.07 m ³ /s	± 2.5 %

NOTE Air flow meters that comply with BS 1042-1.1 and BS 1042-1.2 will satisfy the requirements for accuracy given in Table 1 and do not require calibration.

4.1.2 Checking

4.1.2.1 Air flow meters shall be checked before their initial use and subsequently at intervals not exceeding 12 months. One of the following methods of checking shall be employed.

4.1.2.2 For flow meters complying with BS 1042-1.1 and BS 1042-1.2, all critical dimensions shall be measured. If any of the measured dimensions does not comply with the standard, then the air flow meter shall either be dimensionally corrected or be calibrated in accordance with **4.1.2.3** before further use.

4.1.2.3 Other air flow meters shall be calibrated against a flow meter complying with BS 1042-1.1 and BS 1042-1.2 or by using the pitot-static traverse technique described in BS 1042-2.1. The calibration shall be for a minimum of five flow rates equally spaced throughout the range of the flow meter being calibrated.

4.2 Pressure measurement

4.2.1 Pressure-measuring instruments

4.2.1.1 Pressure shall be measured with either a pressure transducer as described in BS 4509 or a liquid-filled manometer.

4.2.1.2 Pressure-measuring instruments shall have accuracies at least as precise as shown in Table 2.

4.2.1.3 Pressure-measuring instruments shall have scale intervals not greater than those shown in Table 2.

Table 2 — Minimum accuracy and maximum scale intervals of pressure-measuring instruments

Pressure range	Minimum accuracy of measurement	Maximum scale interval
Pa	Pa	Pa
From 1.25 to 25	± 0.5	1.0
25 to 250	± 1.25	2.5
250 to 500	± 2.5	5.0
Above 500	± 5.0	10.0

4.2.1.4 Pressure-measuring instruments shall be calibrated before use and recalibrated at intervals not greater than 12 months.

4.2.2 Total pressure

A pitot-static tube as described in BS 1042-2.1 shall be used for all measurements of total pressure at a point in a duct.

4.2.3 Static pressure

4.2.3.1 A pitot-static tube as described in BS 1042-2.1 shall be used for all measurements of static pressure at a point in a duct.

4.2.3.2 Static taps as described in BS 1042-2.1 shall be used to measure wall static pressure.

4.3 Air velocity measurement

4.3.1 At or above 3 m/s

The measurement of velocities at or in excess of 3 m/s shall be carried out using:

- a pitot-static tube as described in BS 1042-2.1; or
- another type of instrument sensitive to velocity, such as one of rotating vane or heated element design. The instrument shall, at any velocity within the measured range, give a velocity reading that varies by no more than $\pm 5\%$ with variation of the flow direction with a conical sector of up to $\pm 15^\circ$ about the specified orientation of the velocity sensor in the airstream. Prior to testing, the instrument shall be calibrated and the user provided with a valid calibration certificate that includes the data necessary to make appropriate corrections for changes in temperature.

4.3.2 Below 3 m/s

NOTE 1 As the precise measurement of low air velocities is affected by complex factors and because the range of suitable instruments is limited, it is not possible to specify the use of well-defined instrumentation. Some flexibility is needed in the choice of instruments provided the primary requirements are met.

NOTE 2 For all air velocity measuring devices it is necessary to have information on the following main characteristics.

- influence of flow direction;
- influence of natural convection;
- influence of air temperature;
- time constant.