

Methods for

Aerodynamic testing of constant and variable dual or single duct boxes, single duct units and induction boxes for air distribution systems

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- Heating and Ventilating Contractors' Association
- Hevac Association
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Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Definitions	1
3 Summary of tests	2
4 Symbols and suffixes	2
5 Instrumentation	3
6 Leakage tests	4
7 Test for flow rate control	5
8 Boxes with variable rate of air flow at constant inlet pressure	7
9 Test for flow rate characteristics of single duct units	7
10 Test for temperature mixing efficiency of dual duct boxes	8
11 Tests for induction boxes	9
Figure 1 — Leakage test, air supply duct	9
Figure 2 — Typical air supply arrangement for tests on single duct boxes and/or units	12
Figure 3 — Typical air supply arrangement for tests on dual duct boxes	13
Figure 4 — Examples of the determination of “minimum pressure differential”	14
Figure 5 — Typical graph resulting from tests described in 8.4	15
Figure 6 — Typical graph for tests on a single duct unit	16
Figure 7 — Typical air supply arrangement for mixing efficiency tests showing location of instrumentation	17
Figure 8 — Mixing efficiency: typical outlet duct arrangement (single outlet)	18
Figure 9 — Mixing efficiency: points of temperature measurement in outlet extension duct of multiple outlet box	18
Figure 10 — Typical induction box test installation	19
Table 1 — Symbols	3
Table 2 — Ranges and accuracies of measurement of air flow meters not employed for determining leakage rate	3
Table 3 — Ranges and accuracies of measurement of air flow meters for determining leakage rate	3
Table 4 — Pressure measuring instruments: range, accuracy and scale intervals	4
Table 5 — Pressure differentials	6
Publications referred to	Inside back cover

Foreword

This revision of BS 4979 has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Committee and incorporates in one standard the aerodynamic testing of both constant flow and variable flow rate assemblies. It supersedes BS 4979-1:1973 and BS 4979-2:1974, which are withdrawn.

In preparing this British Standard, account has been taken of current practice in the industry and of the work of ISO/TC 144, Air distribution and air diffusion, in preparing ISO 5220, covering aerodynamic testing and rating of constant and variable dual or single duct boxes and single duct units.

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, 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 British Standard describes methods for the aero-dynamic testing of assemblies suitable for use with air distribution systems operating at high or low velocity and high or low pressure.

The standard describes methods of test for the following:

- a) leakage;
- b) flow rate control;
- c) flow rate characteristics for single duct units;
- d) temperature mixing efficiency of a dual duct box;
- e) induced flow rate and secondary air leakage of induction boxes;
- f) pressure requirement of induction boxes.

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

air distribution

the transportation of air to and from the treated space or spaces generally by means of ducts

2.2

dual duct box

an assembly that includes a mixing section in order to mix two air flows of different conditions in predetermined portions, which are automatically adjusted by control valves, and means of regulating the air flow at a predetermined value

2.3

single duct box

an assembly having one air inlet and means of regulating the air flow rate at a predetermined value. Some single duct boxes have facilities for easily varying the predetermined value

2.4

single duct unit

an assembly having one air inlet, the flow rate of which may be adjusted by a manually operated valve

2.5

casing

an enclosure normally housing other components and generally made of metal lined with material for thermal insulation and/or acoustic attenuation. Connections are provided for the inlet(s) and outlet(s)

2.6

flow rate controller

a device mounted within the casing for the purpose of maintaining a constant air flow rate through the casing when the pressure differential between the high and low pressure sides varies within the limits for which the equipment is designed

NOTE A flow rate controller normally maintains constant air flow rate to within $\pm 5\%$ of the maximum air flow rate of the device from the pressure differential range of about 0.1 kPa to 1.5 kPa (1 mbar to 15 mbar).

The three different types of flow rate controller are:

- a) *mechanical constant flow rate controller*. Self-actuating and deriving its power from the air stream and not from any external force;
- b) *mechanical variable flow rate controller*. The same as a) but with its flow rate value varied by an external signal;
- c) *pneumatic, electric, etc. flow rate controller*. A controller deriving its power from an external source. This type of controller can be of either the constant or variable type.

2.7

induction box

a variable flow rate assembly in which the secondary air flow from the surrounding space is induced by means of primary air in order to provide a substantially constant output flow rate, the control signal being provided by a thermostat or similar device

2.8

mixing section

a section for mixing two air streams at different temperatures or humidities, having two inlet ducts with valves controlling the flow rate of air being discharged by each duct into the casing

NOTE Valves can be operated by electric or pneumatic actuators or by direct system pressure actuation.

2.9

valve

a component inserted into air ducts permitting modification of the air resistance of the system and consequently changing the air flow rate and shutting off the air flow completely

2.10**control valve**

a component inserted into air ducts permitting modification of the air resistance of the system and consequently controlling the air flow rate and providing shut-off of the air flow

3 Summary of tests**3.1 General**

The tests for each type of equipment are listed in **3.2** to **3.5**.

3.2 Dual duct boxes

- a) Test for control valve leakage. See **6.1**
- b) Test for casing leakage. See **6.2**
- c) Test for flow rate control (constant or variable). See clause **7**
- d) Test for temperature mixing. See clause **10**

3.3 Single duct boxes

- a) Test for control valve leakage. See **6.1**
- b) Test for casing leakage. See **6.2**
- c) Test for constant flow rate control. See clause **7**
- d) Test for variable flow rate control:
 - 1) throughout the operating range;
 - 2) if capable of being reduced to zero;
 - 3) if fitted with an inlet valve. See clause **8**

3.4 Single duct units

- a) Test for inlet damper leakage. See **6.1**
- b) Test for casing leakage. See **6.2**
- c) Test for flow rate characteristics. See clause **9**

3.5 Induction boxes

- a) Tests for leakage. See **11.1**
- b) Tests for induction flow rate. See **11.2**
- c) Tests for pressure requirements. See **11.3**

4 Symbols and suffixes**4.1 Symbols**

The symbols used in this British Standard are as defined in Table 1.

4.2 Suffixes

The suffixes used in this British Standard are as follows.

- a) 1 is the inlet of the unit under test.
- b) 2 is the outlet of the unit under test.
- c) c is the cold side.
- d) h is the hot side.
- e) u is the measuring point upstream of the flow meter.

Table 1 — Symbols

Symbol	Quantity	Corresponding SI unit	Dimensions
A	Internal cross-sectional area of duct	m^2	L^2
D_e	Equivalent diameter $\sqrt{\frac{4A}{\pi}}$	m	L
p	Absolute static pressure	Pa	$\text{M L}^{-1} \text{T}^{-2}$
p_a	Atmospheric pressure	Pa	$\text{M L}^{-1} \text{T}^{-2}$
p_d	Velocity pressure $\rho \frac{v^2}{2}$	Pa	$\text{M L}^{-1} \text{T}^{-2}$
p_r	Stagnation (or absolute total) pressure	Pa	$\text{M L}^{-1} \text{T}^{-2}$
p_s	Static gauge pressure ($p - p_a$)	Pa	$\text{M L}^{-1} \text{T}^{-2}$
p_t	Total pressure ($p_r - p_a$)	Pa	$\text{M L}^{-1} \text{T}^{-2}$
Δp	Flow meter pressure difference	Pa	$\text{M L}^{-1} \text{T}^{-2}$
Δp_t	Conventional total pressure differential for an air density of 1.2 kg/m^3 at the inlet to the assembly under test	Pa	$\text{M L}^{-1} \text{T}^{-2}$
q_v	Volume rate of air flow at the flow meter	m^3/s	$\text{L}^3 \text{T}^{-1}$
q_{vL}	Leakage volume rate of air flow through a closed inlet valve or variable flow rate controller set for zero flow ^a	m^3/s	$\text{L}^3 \text{T}^{-1}$
v	Velocity	m/s	L T^{-1}
Δy	Conventional value of energy loss per unit mass	J/kg	$\text{L}^2 \text{T}^{-2}$
ρ	Air density	kg/m^3	M L^{-3}
Θ	Thermodynamic temperature	K	Θ
θ	Celsius temperature	$^{\circ}\text{C}$	θ

^a Or the appropriate measurable value, in suitable units, relating to the positional indication of the control valve, or the setting of the variable air flow rate controller, for electric, system-powered or other types of assembly.

5 Instrumentation

5.1 Air flow rate measurement

5.1.1 Air flow meters, with the exception of those employed to determine leakage rate, shall have the ranges and accuracies shown in Table 2.

Table 2 — Ranges and accuracies of measurement of air flow meters not employed for determining leakage rate

Range	Accuracy of measurement
m^3/s	%
0.07 to 7	2.5
0.007 to 0.07	5

5.1.2 Air flow meters employed to determine leakage rate shall have the ranges and accuracies shown in Table 3.

Table 3 — Ranges and accuracies of measurement of air flow meters for determining leakage rate

Range	Accuracy of measurement	
m^3/s	m^3/s	%
< 0.018	0.0009	
> 0.018		5

NOTE Air flow meters complying with BS 1042-1.1 and BS 1042-1.2 will satisfy the accuracies given in 5.1.1 and 5.1.2 and do not require calibration.

5.1.3 Leakage flow rates measured by other devices such as variable area flow meters or integrating flow meters of the positive displacement type shall be calibrated in accordance with 5.1.5.

5.1.4 Meters requiring calibration in situ shall be calibrated using the pitot static tube traverse technique described in BS 1042-2.1 for a minimum of five flow rates equally spaced throughout the range of the flow meter.

5.1.5 Flow meters shall be checked at intervals not exceeding 24 months. One of the following test methods shall be employed.

- a) For flow meters complying with BS 1042-1.1 and BS 1042-1.2, all critical dimensions shall be checked.
- b) For flow meters initially calibrated in situ, recalibration shall be carried out using the same conditions as used for the initial calibration.
- c) For flow meters removable from the test installation, a check shall be made at a minimum of five flow rates equally spaced throughout the range of the flow meter against a flow meter complying with BS 1042-1.1 and BS 1042-1.2.

5.2 Pressure measurement

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

5.2.2 Static pressure

5.2.2.1 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.

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

5.2.3 Pressure measuring instrumentation

5.2.3.1 Pressure shall be measured with either a pressure transducer as described in BS 4509-1 or a liquid-filled manometer.

5.2.3.2 Pressure measuring instruments shall have the ranges and accuracies shown in Table 4.

5.2.3.3 Pressure measuring instruments shall have scale intervals not greater than those shown in Table 4.

Table 4 — Pressure measuring instruments: range, accuracy and scale intervals

Range	Accuracy of measurement	Maximum scale interval
Pa	Pa	Pa
1.25 to 25	± 0.25	1.25
25 to 250	± 2.5	2.5
250 to 500	± 2.5	5.0
Above 500	± 25	25

5.2.3.4 Pressure measuring instruments shall be recalibrated at intervals not greater than 24 months.

5.3 Temperature measurement

Measurement of temperature shall be by means of mercury-in-glass thermometers, resistance thermometers or thermocouples. Instruments shall be graduated or give readings in intervals not greater than 0.5 K and shall be calibrated to an accuracy of 0.25 K.

6 Leakage tests

6.1 Valve leakage

6.1.1 Principle. To measure control valve leakage or leakage past a variable flow rate controller in the shut-off position under conditions of actual operation with the valve closing against the maximum recommended static pressure conditions.

NOTE Since small flow rates (substantially zero) exist during the closed valve condition, the flow rate means used to measure these small flow rates will have a high pressure loss when the valve is open. This precludes a high pressure in the inlet duct until the valve approaches the closed position. As the valve is closed and the flow rate decreases, the inlet static pressure will increase to approximately the recommended maximum inlet pressure.

6.1.2 Test installation. An air supply duct as shown typically in Figure 1 shall be connected to the inlet of the closed valve and/or control valve. All other apertures in the assembly shall be open.

NOTE The duct should be connected to an air supply system that is preferably of the same type used to determine the characteristics of the measured pressure differential versus air flow rate. (See Figure 2 or Figure 3.)

6.1.3 Test procedure

6.1.3.1 Positioning of controls. The valve and/or control valve shall always be operated by means of the actuator recommended for use with the box.

At the commencement of each test (before starting the fan), cycle the valve and/or control valve 20 times between the fully open and fully closed positions by means of the actuator, concluding with the valve and/or control valve positioned as follows.

- a) For single duct boxes with an inlet valve, a control valve or a flow rate controller capable of acting as a valve, position the valve so that it is fully closed by the actuator.
- b) For single duct units with an inlet valve or a control valve, position the valve so that it is fully closed by the actuator.
- c) For dual duct boxes, position the inlet control valve so that the inlet under test is fully closed by the actuator.