International Standard ISO 7244

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Air distribution and air diffusion — Aerodynamic testing of dampers and valves

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 7244 was developed by Technical Committee ISO/TC 144, *Air distribution and air diffusion*, and was circulated to the member bodies in January 1982.

It has been approved by the member bodies of the following countries:

Australia	Egypt, Arab Rep. of	Romania
Austria	Germany, F.R.	Spain
Belgium	Italy	Sweden
Brazil	Korea, Rep. of	Switzerland
Czechoslovakia	Poland	United Kingdom

The member bodies of the following countries expressed disapproval of the document on technical grounds:

France
USA

Air distribution and air diffusion — Aerodynamic testing of dampers and valves

1 Scope

This International Standard specifies methods for the aerodynamic testing and rating of dampers and valves used in air distribution systems with pressures up to 2 000 Pa. (See clause 4.)

The tests incorporated in this International Standard are :

a) leakage past a closed damper or valve;

b) casing leakage;

c) flow rate/pressure requirement characteristics.

The acoustic testing of dampers and valves is not included in this International Standard.

2 Field of application

The tests specified in clause 1 apply to the following :

a) testing for damper and valve leakage;

b) testing of casing leakage;

c) testing of flow rate/pressure requirements for dampers or valves mounted in a duct system.

NOTE — Certain aspects of the dynamic performance of dampers or valves are dependent upon the air distribution system to which they are connected and are, therefore, difficult to measure in isolation. Such considerations have led to the omission of these aspects of the dynamic performance measurements from this International Standard.

Also, in common with other air distribution components, the results from tests carried out in accordance with this International Standard may not be directly applicable if the damper or valve is situated in an area of non-uniform flow.

3 References

ISO 3258, *Air distribution and air diffusion — Vocabulary.*

ISO 5221, *Air distribution and air diffusion — Guide to methods of measuring air flow rate in an air handling duct.*

4 Definitions

The definitions of terms used in this International Standard are in accordance with ISO 3258.

5 Symbols and abbreviations

The following nomenclature is used throughout this International Standard.

5.1 Symbols

Symbol	Designation	Units	Dimensions
A	Internal cross-sectional area of duct	m^2	L^2
D_e	Equivalent diameter $\sqrt{\frac{4A}{\pi}}$	m	L
p	Absolute pressure	Pa	$ML^{-1}T^{-2}$
p_a	Atmospheric pressure	Pa	$ML^{-1}T^{-2}$
p_d	Velocity pressure $\varrho \frac{v^2}{2}$	Pa	$ML^{-1}T^{-2}$
p_r	Stagnation (or absolute total) pressure	Pa	$ML^{-1}T^{-2}$
p_s	Static gauge pressure $(p - p_a)$	Pa	$ML^{-1}T^{-2}$
p_t	Total pressure $(p_r - p_a)$	Pa	$ML^{-1}T^{-2}$
Δp	Flow meter pressure difference	Pa	$ML^{-1}T^{-2}$
Δp_t	Conventional total pressure differential for an air density of 1,2 kg/m^3 at the inlet to the damper or valve under test	Pa	$ML^{-1}T^{-2}$
ζ	Mean total pressure loss coefficient		
q_V	Volume rate of air flow at the flow meter	m^3/s	L^3T^{-1}
q_{VL}	Leakage volume rate of air flow	m^3/s	L^3T^{-1}
ϱ	Air density	kg/m^3	ML^{-3}
θ	Temperature	°C	Θ
v	Velocity	m/s	LT^{-1}

5.2 Suffixes

1 is the inlet of the damper or valve under test;

2 is the outlet of the damper or valve under test;

u is the measuring point upstream of flow meter;

n is the value at selected point of flow rate/static pressure curve.

6 Instrumentation

6.1 Air flow rate measurement

The air flow rate shall be measured using instruments in accordance with ISO 5221.

6.1.1 Air flow meters shall have the following ranges and accuracies:

Range m^3/s	Accuracy of measurement %
From 0,07 to 7	± 2,5
From 0,007 to 0,07	± 5

Flow meters may be calibrated *in situ* by means of the pitot static tube traverse techniques described in ISO 5221.

6.1.2 Leakage air flow meters shall have the following ranges and accuracies:

Range m^3/s	Accuracy of measurement
Up to and including 0,018	0,000 9 m^3/s
More than 0,018	± 5 %

Alternatively other devices such as variable area, flow-rate meters or integrating air flow meters of the positive displacement type may be used if calibrated in accordance with the specifications given in 6.1.3 c).

6.1.3 Flow meters shall be checked at intervals as appropriate but not exceeding 24 months. This check may take the form of one of the following :

a) a dimensional check for all flow meters not requiring calibration;

b) a check calibration over their full range using the original method employed for the initial calibration of meters calibrated *in situ*;

c) a check against a flow meter which meets International Standard flow meter specifications.

6.2 Pressure measurement

6.2.1 Pressure in the duct shall be measured by means of a liquid filled, calibrated manometer.

6.2.2 The maximum scale interval shall not be greater than the characteristics listed for the accompanying range of manometer.

Range Pa	Maximum scale interval Pa
From 1,25 to 25	1,25
From 25 to 250	2,5
From 250 to 500	5,0
Above 500	25

6.2.3 For air flow rate measurements, the minimum pressure differential shall be :

a) 25 Pa with an inclined tube manometer or micromanometer;

b) 500 Pa with a vertical tube manometer.

6.2.4 Calibration standards shall be :

a) for instruments within the range 1,25 to 25 Pa, a micromanometer accurate to ± 0,25 Pa;

b) for instruments within the range 25 to 500 Pa, a manometer accurate to ± 2,5 Pa (hook gauge or micromanometer);

c) for instruments within the range 500 Pa and upwards, a manometer accurate to ± 25 Pa (vertical manometer).

6.3 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 °C and calibrated to an accuracy of 0,25 °C.

7 Leakage tests

7.1 Damper and valve leakage

It is intended to measure damper and/or valve leakage in the shut off position under conditions of actual operation with the damper or valve closing against the maximum recommended static pressure conditions. Since small flow rates exist during the closed damper or valve condition, the method used to measure these small flow rates will introduce a high pressure loss when the damper or valve is open. This precludes a high pressure in the inlet duct until the damper or 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.

The damper or valve shall be set in the closed position either manually or by the means provided by the manufacturer.

7.1.1 An air supply duct similar to that shown in figure 1 shall be connected to the inlet of the damper or valve, the outlet remaining open.

7.1.2 The air supply duct (see figure 1) shall be connected to a suitable air system.

7.1.3 The supply air pressure shall be increased to the maximum recommended inlet pressure, then without any additional adjustment of the supply air system flow rate, the damper or valve shall be modulated to the open position and then returned to the closed position either manually, or by the means provided by the manufacturer. As the damper or valve nears closure the supply air pressure shall be adjusted so as to maintain the maximum recommended inlet static gauge pressure within ± 5 %.

7.1.4 The air flow rate shall be reported as the damper or valve leakage rate expressed in the form X m^3/s at Y Pa.

7.2 Casing leakage

7.2.1 The air supply system described in 7.1 shall be connected to the inlet of the damper or valve under test, with the damper or valve in the open position and the casing outlet sealed.

7.2.2 The test of the casing shall be carried out by subjecting the casing to its maximum recommended pressure. The pressure shall be maintained for 60 s before the measurement of leakage commences.

7.2.3 The test results shall be reported as casing leakage flow rate at the test pressures used.

8 Flow rate/pressure requirement tests

8.1 The damper or valve under test shall be mounted in a system which shall comprise a fan, a means of controlling air flow rate, a flow rate measuring system and test ducts (see figure 2).

8.2 The test ducts shall have cross-sectional dimensions equal to the nominal size of the unit under test or to the duct dimensions recommended by the manufacturer. The upstream test duct shall be straight for a minimum length of 5 D_e. The downstream test duct shall be straight for a minimum length of 10 D_e or 2 m, whichever is the greater.

8.3 Flow straighteners shall be fitted in the upstream test duct at a position 3 D_e from the connection to the damper or valve under test.

8.4 The velocity profile near the upstream connection to the damper or valve under test shall be uniform to ± 10 % of the mean value over the test duct cross section, excluding the area within 15 mm of the duct walls. A velocity survey at ten equally spaced intervals along a pair of mutually perpendicular axes shall be carried out to confirm that the velocity profile is within these limits. Wire mesh screens located no closer than 2,5 D_e to the upstream connection to the damper or valve under test may, if necessary, be incorporated to achieve a suitably uniform velocity profile.

8.5 The upstream duct static gauge pressure (p_{s1}) shall be measured by means of four static pressure tappings 1,5 D_e from the upstream connection to the damper or valve under test. These pressure taps shall, for a rectangular duct, be at the centre of each side and for a circular duct equally spaced around the circumference. The pressure taps shall be connected to form a piezometric ring. Alternatively, a single pitot static probe shall be used.

8.6 The air temperature shall be measured at the flow meter and at a position 2 D_e upstream of the damper or valve under test and during the test the temperature variation shall not be greater than 3 K.

8.7 The damper or valve shall be set in its fully open position. The tests shall then be carried out in the following manner.

8.7.1 The test shall be carried out using a minimum of five air flow rates distributed evenly throughout the test range of air flow rates. The lowest air flow rate shall be chosen so that the test duct static pressure is not less than 10 Pa.

8.7.2 The damper or valve shall then be removed from the test installation and, the upstream test duct connected directly to the downstream test duct, the procedure outlined in 8.7.1 shall be repeated at five air flow rates covering the same range as used previously.

8.8 The following data shall be recorded :

Symbol	Designation	Units
$p_{s1(a)}$	Inlet duct static gauge pressure with the damper or valve installed	Pa
$p_{s1(b)}$	Inlet duct static gauge pressure with the damper or valve removed	Pa
p_a	Atmospheric pressure	Pa
θ_1	Air temperature at inlet to the damper or valve under test	°C
Δp 1)	Flow meter pressure difference	Pa
p_{su}	Static gauge pressure immediately upstream of the flow meter	Pa
θ_u	Air temperature immediately upstream of the flow meter	°C

1) Or the appropriate parameter which relates to q_V.

8.9 For each test, determine the volume air flow rate at the flow meter (q_V). If there are significant differences in the air temperature and static pressure between the flow meter and the damper or valve under test so that the air density ratio :

$\frac{\varrho_u}{\varrho_1}$ is less than 0,98 or greater than 1,02 then the following correction should be applied.

$$q_{V1} = q_V \times \frac{\varrho_u}{\varrho_1}$$

where

$$\varrho_u = 3{,}47 \times 10^{-3} \left[\frac{p_{su} + p_a}{\theta_u + 273} \right]$$

and

$$\varrho_1 = 3{,}47 \times 10^{-3} \left[\frac{p_{s1} + p_a}{\theta_1 + 273} \right]$$

Otherwise q_{V1} may be taken as equal to q_V

8.10 Having measured values of $p_{s1(a)}$ and $p_{s1(b)}$ and also determined corresponding values of q_{V1} in accordance with 8.9, the following functions shall be plotted on linear graph paper :

$\lg p_{s1(a)}$ vs $\lg q_{V1}$

$\lg p_{s1(b)}$ vs $\lg q_{V1}$

The best fit straight line with a slope of 2 should then be drawn through each set of data points (see figure 3).

For the tests and test results to comply with the terms of this International Standard, the deviation of individual test points from the straight lines drawn should not be greater than ± 5 %.

8.11 Having complied with the requirements of 8.10, select a value of flow rate q_{V1n} within the range of the flow rates investigated. The static gauge pressure requirement of the unit under test at this condition is :

$$p_{sn} = p_{s1(a)n} - p_{s1(b)n} \text{ (see figure 3).}$$

8.12 The velocity pressure p_{dn} shall be calculated based on the value of q_{V1n} :

$$p_{dn} = \frac{1}{2} \varrho_{1n} \left(\frac{q_{V1n}}{A_1} \right)^2$$

where

$$\varrho_{1n} = 3{,}47 \left[\frac{p_{s1(a)n} + p_a}{\theta_1 + 273} \right] \times 10^{-3}$$

8.13 The mean total pressure loss coefficient, ζ, shall be calculated using the equation :

$$\zeta = \frac{p_{sn}}{p_{dn}}$$

8.14 All total and static pressure losses quoted from the test results shall be calculated using this total pressure loss coefficient.

8.15 The test described in clause 8 may be conducted with the damper other than at the fully open position, in which case the test results shall be referenced to the particular damper setting chosen.

8.16 The test results shall be reported as pressure requirements for the flow rates tested.

NOTE — In the context of this International Standard the damper setting shall be defined as the angle or position of the blade(s) and/or the physical displacement of the adjustable component(s) in relation to a datum.

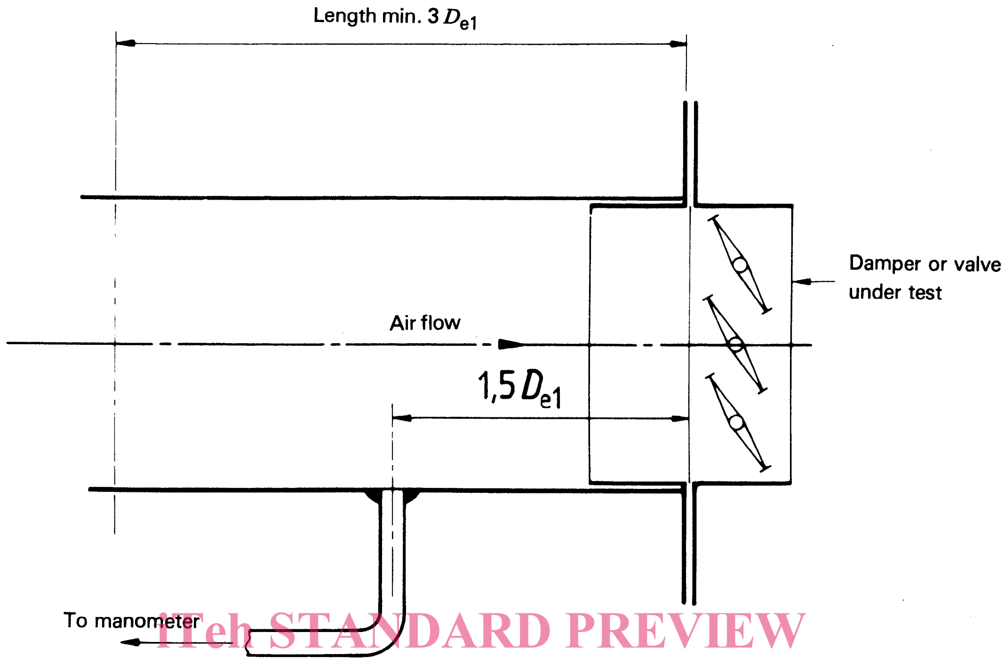

Figure 1 — Leakage air supply duct

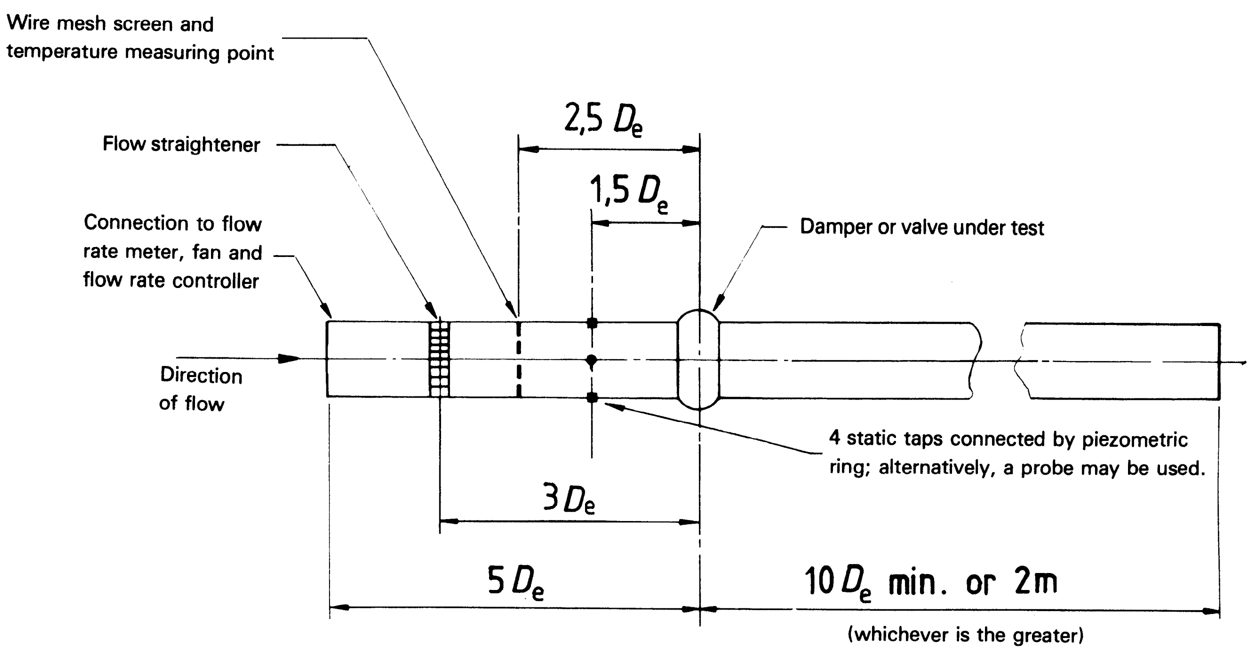

Figure 2 — Flow rate/pressure requirement — Typical test arrangement

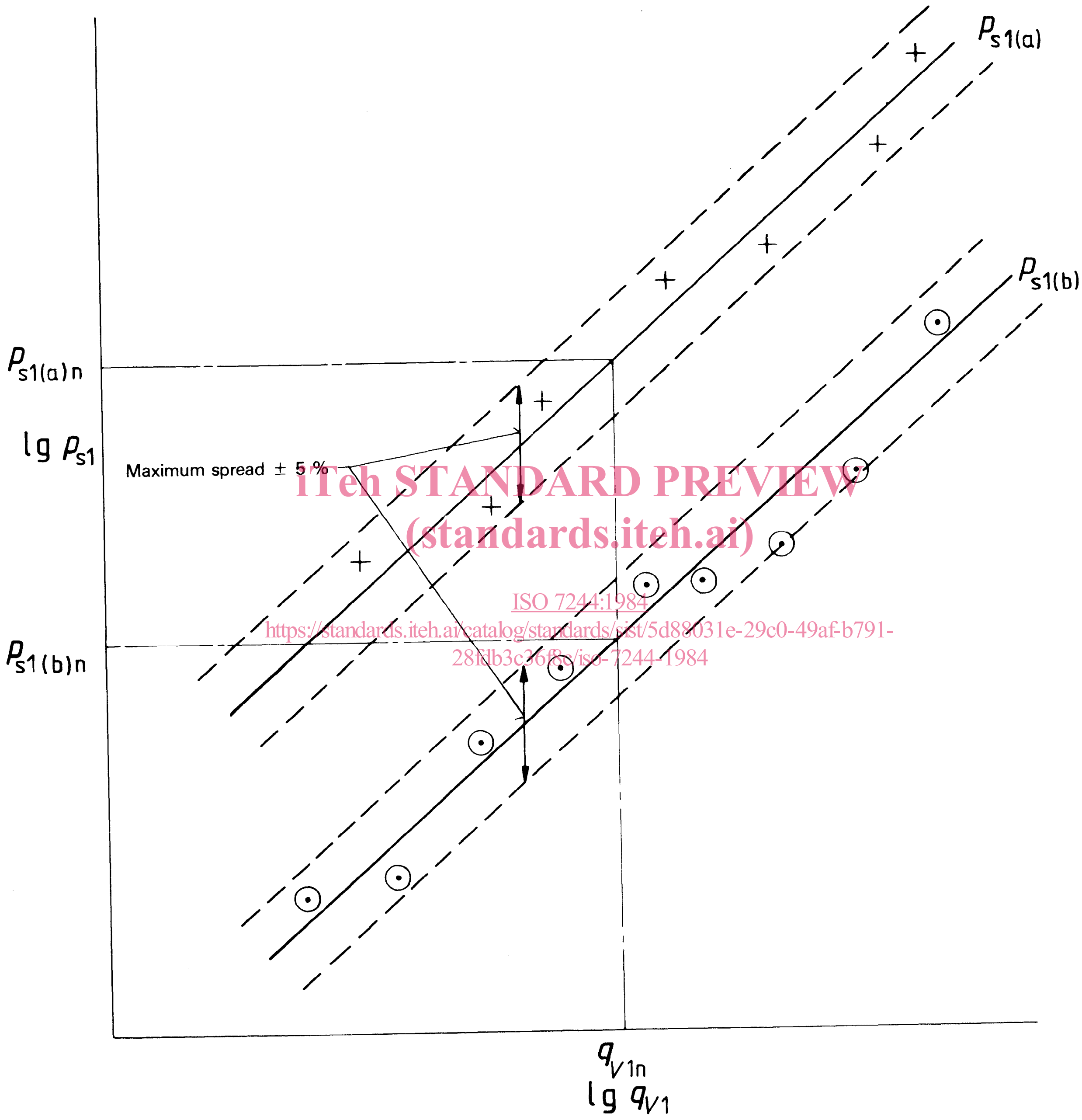

Figure 3 — Flow rate/pressure requirement — Plot of static pressures and corresponding flow rate at plane 1