SLOVENSKI STANDARD
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Prezračevanje stavb - Naprave za dovod in odvod zraka - Aerodinamično preskušanje dušilnikov in loput

Ventilation for buildings - Air terminal devices - Aerodynamic testing of damper and valves

Lüftung von Gebäuden - Komponenten des Luftverteilersystems - Aerodynamische Prüfung von Drossel- und Absperrelementen

Ventilation des batiments - Bouches d'air - Essais aérodynamiques des registres et clapets

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Ventilation for buildings - Air terminal devices - Aerodynamic testing of damper and valves

Ventilation des bâtiments - Bouches d'air - Essais aérodynamiques des registres et clapets

Lüftung von Gebäuden - Geräte des Luftverteilungssystems - Aerodynamische Prüfungen von Drossel- und Absperrelementen

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Foreword

This document (EN 1751:2014) has been prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2014, and conflicting national standards shall be withdrawn at the latest by July 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1751:1998.

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1 Scope

This European Standard specifies methods for the testing and rating of dampers and valves used in air distribution systems with pressure differences up to 2 000 Pa.

The tests incorporated in this European Standard are:

a) leakage past a closed damper or valve (for classification see Annex C);

b) casing leakage (for classification see Annex C);

c) flow rate/pressure requirement characteristics;

d) torque: (see Annex A);

e) thermal transmittance: (see Annex B).

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

The tests specified above apply to the following:

f) measurement of leakage past a closed damper or valve;

g) measurement of casing leakage;

h) determination of flow rate and pressure requirements;

i) measurement of torque characteristics (see Annex A);

j) measurement of thermal transfer characteristics to determine insulation properties (see Annex B).

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12792, *Ventilation for buildings - Symbols, terminology and graphical symbols*

EN ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements (ISO 5167-1)*

EN ISO 5167-2, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 2: Orifice plates (ISO 5167-2)*

EN ISO 5167-3, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 3: Nozzles and Venturi nozzles (ISO 5167-3)*

EN ISO 5167-4, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 4: Venturi tubes (ISO 5167-4)*

3 Terms, definitions, symbols and suffixes

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12792 apply.

3.2 Symbols

The symbols used in this document are given in Table 1.

Table 1 — Symbols

Symbol	Quantity	Unit
A	Internal cross-sectional area of duct	m^2
C_D	Coefficient of discharge	-
D_e	Equivalent hydraulic diameter Circular ducts: $\sqrt{\frac{4A}{\pi}}$ Square/Rectangular ducts: $\frac{2ab}{a+b}$	m
p	Absolute pressure	Pa
pa	Atmospheric pressure	Pa
p_d	Velocity pressure $1/2\ \rho\ v^2$	Pa
p_t	Stagnation or absolute total pressure	Pa
p_s	Static gauge pressure (p - p_a)	Pa
Δp_s	Pressure difference across the damper or valve under test	Pa
Δp	Flow meter differential pressure	Pa
Δp_t	Conventional total pressure difference for an air density of 1,2 $kg \cdot m^{-3}$ at the inlet to the damper or valve under test	Pa
q_v	Volume rate of air flow at the flow meter	$l \cdot s^{-1}$
q_{vL}	Leakage volume rate of air flow	$l \cdot s^{-1}$
q_{vLBA}	Closed blade air leakage factor, volume rate of air flow per unit duct cross sectional area	$l \cdot s^{-1} \cdot m^{-2}$
q_{vLCA}	Case air leakage factor, volume rate of air flow per reference casing area (which is taken as perimeter of damper multiplied by an equivalent length of 1 m)	$l \cdot s^{-1} \cdot m^{-2}$
v	Velocity	$m \cdot s^{-1}$

Symbol	Quantity	Unit
s	Position of damper setting	%, α or m
T	Torque	N·m
U	Thermal transmittance coefficient	$W·K^{-1}·m^{-2}$
q	Temperature	°C
ρ	Air density	$kg·m^{-3}$
ξ	Pressure loss coefficient	-

3.3 Suffixes

The following suffixes shall be used with the symbols given in Table 1.

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 the flow meter;

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

4 Instrumentation

4.1 Air flow rate measurement

4.1.1 The air flow rate shall be measured using instruments in accordance with EN ISO 5167-1, EN ISO 5167-2, EN ISO 5167-3 and EN ISO 5167-4, or other instruments which have equivalent calibrated performance.

4.1.2 Air flow meters shall have a minimum calibration accuracy of ± 2,5 % over the whole range.

NOTE If necessary, flow meters can be calibrated *in situ* by means of the Pitot static tube traverse technique described in ISO 3966.

4.1.3 Flow meters shall be checked at intervals as appropriate but not exceeding 12 months. This check can take the form of one of the following:

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

b) a 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 flow meter specifications according to EN ISO 5167-1, EN ISO 5167-2, EN ISO 5167-3 or EN ISO 5167-4 as appropriate.

4.1.4 Leakage air flow meters shall have a minimum indicated accuracy according to the ranges in Table 2.

Table 2 — Accuracy of leakage air flow meters

Range $l·s^{-1}$	Accuracy of measurement
Up to and including 0,018	± 0,000 9 $l·s^{-1}$
More than 0,018	± 5 %

NOTE Alternatively, other devices such as variable area, flow-rate meters or integrating air flow meters of the positive displacement type can be used if calibrated in accordance with 4.1.3 c).

4.2 Pressure measurement

4.2.1 Pressure in the duct shall be measured by means of a liquid filled, calibrated manometer or any other device conforming to 4.2.2.

4.2.2 The resolution shall not be greater than the characteristics listed for the accompanying range of manometers, given in Table 3.

Table 3 — Resolution for the ranges of manometers

Range Pa	Resolution Pa
Up to and including 50	0,1
From 50 to 250	1
From 250 to 500	5,0
Above 500	25,0

4.2.3 The measured value of differential pressure should be greater than 10 % of the range of the measurement device used.

EXAMPLE With a micromanometer with a range from 0 to 1 000 Pa the minimum differential pressure to be measured is 100 Pa.

4.2.4 The uncertainty of calibration standards shall be:

a) for instruments with a measuring range up to 100 Pa, equal or better than ± 0,5 Pa;

b) for instruments with a measuring range over 100 Pa, equal or better than ± 0,5 % of reading.

4.3 Temperature measurement

Measurement of temperature shall be, for example, by means of mercury-in-glass thermometers, resistance thermometers or thermo-couples. Instruments shall have a resolution better than 0,5 K and be calibrated to an accuracy of ± 0,25 K.

5 Leakage tests

5.1 General

Damper leakage performance could vary depending on whether the damper is subjected to positive or negative pressure. The manufacturer shall specify the pressure conditions for test.

5.2 Damper and valve leakage

5.2.1 Measurement of damper and/or valve leakage in the shut-off position shall be made 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 difference 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 difference will increase to approximately the recommended inlet pressure.

5.2.2 The damper or valve shall be cycled 10 times between the fully open and fully closed positions of the actuator at the start of each test (before starting the fan of the air supply system) concluding with the damper or valve in the fully closed position.

NOTE In all cases in the closed position, the damper drive is subject to a torque rating recommended by the manufacturer.

5.2.3 The damper or valve under test shall be connected to a test installation similar to that shown in Figure 1a) or Figure 1b)). A suitable air supply shall be connected to the duct. In both cases, care shall be taken to ensure that duct joints are sealed to manufacturer's instructions.

5.2.4 The supply air pressure shall be increased to the maximum recommended inlet pressure difference in accordance with the appropriate classification from Figure C.1 and Figure C.2. The damper or valve is then modulated to the open position, without any additional adjustment of the supply air system flow rate, and then returned to the closed position either manually or by the means provided by the manufacturer. The supply air pressure shall be adjusted, as the damper or valve nears closure, to maintain the recommended inlet static gauge pressure difference within ± 5 %. The above process is to ensure that the closed condition is as representative as possible of typical operation with airflow present.

NOTE The air flow measuring device for leakage measurement may have to be disconnected in the above process to avoid any potential damage to a device for measuring low air rates.

5.2.5 Report the damper or valve air leakage factor as a function of test pressure difference in the closed position. Also include classification (see Annex C).

5.3 Casing leakage

5.3.1 The test installation shall be similar to that shown in Figure 2 a)) or Figure 2 b)). The damper or valve casing outlet shall be sealed according to the instructions of the manufacturer. The damper or valve shall be set to the open position.

5.3.2 The test of the casing shall be carried out by subjecting the casing to its maximum recommended pressure in accordance with 5.2.4. The pressure shall be maintained for 60 s before the measurement of leakage commences.

5.3.3 Report the test results as casing air leakage factor as a function of test pressure. Also include classification (see Annex C).

6 Flow rate and pressure tests

6.1 Ducted method

6.1.1 This method applies for dampers or valves mounted within a duct.

6.1.2 The damper or valve under test shall be mounted in a system comprising a fan, a means of controlling air flow rate, a flow rate measuring system and test ducts (see Figure 3).

6.1.3 The test ducts shall have cross-sectional dimensions equal to the nominal size of the unit under test or to the manufacturer's instructions. The upstream test duct shall be straight for a minimum length of $5D_{e1}$. The downstream test duct shall be straight for a minimum length of $5D_{e2}$ or 2 m, whichever is the greatest.

6.1.4 Flow straighteners shall be fitted in the upstream test duct at a position $3D_{e1}$ from the connection to the damper or valve under test or, alternatively a straight duct shall be used without a flow straightener.

6.1.5 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. Carry out a velocity survey at ten equally spaced intervals along a pair of mutually perpendicular axes to confirm that the velocity profile is within these limits. Wire mesh screens located no closer than $2{,}5D_{e1}$ to the upstream connection to the damper or valve under test can, if necessary, be incorporated to achieve a suitably uniform velocity profile.

6.1.6 The upstream duct static gauge pressure (p_{s1}) shall be measured by means of four static pressure tappings $1{,}5D_{e1}$ from the upstream connection to the damper or valve under test. For a rectangular duct, these pressure taps shall be at the centre of each side and, for a circular duct, equally spaced around the circumference. Connect the pressure taps to form a piezometric ring. Alternatively, use a single Pitot static probe.

6.1.7 The air temperature shall be measured at the flow meter and at a position $2{,}5D_{e1}$ upstream of the damper or valve under test, and, during the test the temperature variation at the same station shall not be greater than 3 K.

6.1.8 The damper or valve shall be set in its fully open position and tests shall be carried out as follows:

6.1.8.1 Use a minimum of five air flow rates distributed evenly throughout the total flow range, and choose the lowest air flow rate so that the test duct static pressure is not less than 10 Pa.

6.1.8.2 Remove the damper or valve from the test installation and connect the upstream test duct directly to the downstream test duct. Repeat the procedure in 6.1.8 at five air flow rates covering the same flow rate range used in 6.1.8.

6.1.9 If required, repeat the procedure described in 6.1.8 with the damper or valve other than in the open position.

6.1.10 Record the data given in Table 4.

Table 4 — Flow rate and pressure test data

Symbol	Quantity	Unit	Uncertainty of measurement
$p_{s1(a)}$	Inlet duct static gauge pressure with the damper or valve installed	Pa	3 %
$p_{s1(b)}$	Inlet duct static gauge pressure with the damper or valve removed	Pa	3 %
p_a	Atmospheric pressure	Pa	1 %
θ_1	Air temperature at inlet to the damper or valve under test	°C	3 %
Δp [a]	Flow meter differential pressure	Pa	3 %
p_{su}	Static gauge pressure immediately upstream of the flow meter	Pa	3 %
θ_u	Air temperature immediately upstream of the flow meter	°C	3 %
S	Position of damper setting	%, α or m	2°

[a] Or the appropriate parameter which relates to q_v.

6.2 Chamber method

6.2.1 General

This method applies for dampers and valves with free inlet and discharge.

6.2.2 Size relationship

The size relationship of test setup apparatus for determination of flow rate and static pressure differential of the device under test shall be limited to the following:

— The chamber cross-sectional area shall be at least 7 times the internal cross sectional area of duct (A) of the device being tested.

— Other dimensions shall respect indications of Figure 4.

6.2.3 Tests

6.2.3.1 Pressure difference according to test chamber method is a statement of the pressure difference required to accelerate the air to a given velocity and overcome any entrance (exit) losses due to the blockage and entrance (exit) conditions.

6.2.3.2 Use a minimum of five air flow rates distributed evenly throughout the total flow range, and choose the lowest air flow rate so that the test duct static pressure is not less than 10 Pa.

6.2.3.3 If required, repeat the procedure described in 6.2.3.2 with the damper or valve other than in the open position.

6.2.3.4 Record the data given in Table 5.

Table 5 —Flow rate and pressure test data

Symbol	Quantity	Unit
Δp_s	Pressure difference across the damper or valve under test	Pa
p_a	Atmospheric pressure	Pa
θ_1	Air temperature at inlet to the damper or valve under test	°C
Δp [a]	Flow meter differential pressure	Pa
p_{su}	Static gauge pressure immediately upstream of the flow meter	Pa
θ_u	Air temperature immediately upstream of the flow meter	°C
S	Position of damper setting	%, α or m

[a] Or the appropriate parameter which relates to q_v.

6.3 Test report

6.3.1 The volume air flow rate at the flow meter (q_v) shall be determined for each test. If there are significant differences in the air temperature and static pressure between flow meter and the damper or valve under test so that the air density ratio is less than 0,98 or greater than 1,02, the following correction shall be applied:

$$q_{v1} = q_v \bullet \frac{\rho_u}{\rho_1} \qquad (1)$$