BRITISH STANDARD

BS EN
60534-8-1:2005

Industrial-process control valves —

Part 8-1: Noise considerations — Laboratory measurement of noise generated by aerodynamic flow through control valves

The European Standard EN 60534-8-1:2005 has the status of a British Standard

ICS 23.060.40; 17.140.20; 25.040.40

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 60534-8-1:2005. It is identical with IEC 60534-8-1:2005. It supersedes BS EN 60534-8-1:2001 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/65, Measurement and control, to Subcommittee GEL/65/2, Elements of systems, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 17 and a back cover.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 1 February 2006

ISBN 0 580 47390 2

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD **EN 60534-8-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM November 2005

ICS 23.060.40; 17.140.20; 25.040.40 Supersedes EN 60534-8-1:2000

English version

Industrial-process control valves Part 8-1: Noise considerations - Laboratory measurement of noise generated by aerodynamic flow through control valves
(IEC 60534-8-1:2005)

Vannes de régulation des processus industriels
Partie 8-1: Considérations sur le bruit - Mesure en laboratoire du bruit créé par un débit aérodynamique à travers une vanne de régulation
(CEI 60534-8-1:2005)

Stellventile für die Prozessregelung
Teil 8-1: Geräuschbetrachtungen - Laboratoriumsmessungen von Geräuschen bei gasdurchströmten Stellventilen
(IEC 60534-8-1:2005)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 60534-8-1:2005 E

Foreword

The text of document 65B/558/FDIS, future edition 2 of IEC 60534-8-1, prepared by SC 65B, Devices, of IEC TC 65, Industrial-process measurement and control, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60534-8-1 on 2005-09-01.

This European Standard supersedes EN 60534-8-1:2000.

This standard has been revised to obtain consistency in describing the methods for measuring internal and external sound pressure measurements and to update the description of the instrumentation from analog to digital.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2006-07-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2008-09-01

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60534-8-1:2005 was approved by CENELEC as a European Standard without any modification.

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CONTENTS

INDUSTRIAL-PROCESS CONTROL VALVES –

Part 8-1: Noise considerations – Laboratory measurement of noise generated by aerodynamic flow through control valves

1 Scope

This part of IEC 60534-8 defines equipment, methods, and procedures for obtaining laboratory measurements of sound pressure levels radiated by control valves and/or associated piping configurations, including fixed restrictions, through which compressible fluids are passing. Control valves discharging to atmosphere are excluded from this standard.

Method A is a uniform method of measuring the radiated noise from the valve and associated test piping and allows a comparison of various measuring results which is beneficial for both user and manufacturer. The noise criteria are expressed by determining the sound pressure level of the valve under consideration.

Method B is a procedure for measuring the sound pressure levels within pipe systems upstream and downstream of the valve under fixed operating conditions. Since inaccuracies due to the pipe transmission are eliminated, this method is preferred for evaluation of the acoustical characteristic of valves.

The noise characteristics to be determined are useful for the following reasons:

a) to compare the performance of different valves;

b) to plan measures for noise abatement;

c) to determine acoustical characteristics of valves and valve assemblies;

d) to enable proper sizing of sound absorbers;

e) to determine possible adverse effects on ultra-sonic flow meter measurements.

2 Normative references

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

IEC 60534-1, *Industrial-process control valves – Part 1: Control valve terminology and general considerations*

IEC 60534 (all parts), *Industrial-process control valves*

IEC 60534-2-3, *Industrial-process control valves – Part 2-3: Flow capacity – Test procedures*

IEC 60534-8-3, *Industrial-process control valves – Part 8-3: Noise considerations – Control valve aerodynamic noise prediction method*

IEC 61260, *Electroacoustics – Octave-band and fractional-octave-band filters*

IEC 61672-1:2002, *Electroacoustics – Sound level meters – Part 1: Specifications*

ISO 3744:1994, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over reflecting plane*

ISO 3745:2003, *Acoustics – Determination of sound power levels of noise sources – Precision methods for anechoic and hemi-anechoic rooms*

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those given in IEC 60534-1 and other parts of IEC 60534, apply.

3.1
test specimen
any valve or combination of valve, reducer, expander, or other fittings for which test data are required

NOTE During blow-down testing a closure mechanism should be used in such a way that the closure member position does not change during blow-down.

3.2
blow-down rate
rate at which the inlet pressure to the test specimen changes

NOTE In the blow-down method of testing, the inlet pressure to the test specimen decays during the test period.

4 Symbols

Symbol	Description	Unit
C	Flow coefficient (C_v, K_v)	Various (see IEC 60534-1)
F_p	Piping geometry factor	1
L_{pi}	Internal sound pressure level at pipe wall	dB(ref P_o)
$\dot{m}$	Mass flow rate	kg/s
Q	Volumetric flow rate	m^3/h
p_1	Inlet absolute pressure	kPa or bar
p_2	Outlet absolute pressure	kPa or bar
Δp	Differential pressure between upstream and downstream pressure taps ($p_1 - p_2$)	kPa or bar
S_i	Measuring area $\pi d_i^2/4$	m^2
T_1	Inlet temperature	K
T_2	Outlet temperature	K
u	Mean (average fluid velocity)	m/s

Symbol	Description	Unit
x	Ratio of pressure differential to inlet absolute pressure ($\Delta p/p_1$)	1
x_T	Pressure differential ratio factor of a control valve without attached fittings at choked flow	1
x_{TP}	Pressure differential ratio factor of a control valve with attached fittings at choked flow	1

5 Method A (external sound pressure measurement)

5.1 Test system

The test system shown in Figure 1 includes

a) pressure regulating devices (optional);

b) test specimen;

c) test section piping;

d) pressure taps;

e) noise-attenuating devices (optional);

f) means of controlling the acoustic environment (chamber is optional);

g) instrumentation.

Alternative test arrangements are shown in Figures 2a and 2b.

5.1.1 Pressure regulating devices

Upstream and/or downstream pressure regulating devices are used to regulate the test pressures. Caution should be taken to avoid pressure drops which will create significant stream-borne noise. If such pressure drops are unavoidable, the use of silencers (see 5.1.5) is recommended as shown in Figure 1. Flowmeters should be installed in accordance with the manufacturers' instructions.

5.1.2 Test specimen

The test specimen and test section shall not be insulated. However, separate tests may be conducted to determine the effects of pipe and/or valve insulation.

5.1.3 Test section piping

There is no limitation concerning the maximum length of downstream and upstream piping connected to the test specimen. The exposed downstream or upstream pipe within the acoustic environment shall be of one-piece construction, i.e., no flanges, circumferential joints or other pipe-wall reinforcements, and at least 2 m in length. This applies to the downstream pipe when conducting downstream noise tests and to the upstream pipe when conducting upstream noise tests.

Any mismatch between the inlet and outlet diameters of the test specimen and the inside diameter of the adjacent piping shall be minimized as far as practical.

Non-insulated pipe shall be used. Pipe material and pipe wall thickness shall be reported in the test data.

5.1.4 Pressure taps

Pressure taps shall be provided for the measurement of pressures. They shall conform to IEC 60534-2-3.

5.1.5 Acoustic environment

The test environment shall be controlled in such a way that background, reflected, and other extraneous noise be at least 10 dB lower than that radiated by the test section. Depending on the test system and the acoustic environment, upstream and downstream silencers may be necessary. General considerations for the acoustic environment can be found in ISO 3744 and ISO 3745. No sound pressure level correction shall be made for the presence of extraneous noise.

5.1.6 Instrumentation

The instrumentation for sound pressure level measurement shall conform to IEC 61672-1, Class 1 or Class 2. Sound level meter characteristics shall conform to IEC 61672-1, Table 2 (weighting A).

Sound level meter calibration and sensitivity test results shall be corrected to sea-level conditions.

Additional instrumentation such as electronic recording devices and computers shall not cause errors in the measured data of more than ±1 dB.

5.2 Test procedure

5.2.1 Test fluids

Air is the preferred fluid to be used in the test procedures. However, other compressible fluids may be substituted for air. The fluid shall be sufficiently dry to ensure that any icing which may take place does not affect the test results. Saturated vapours are not acceptable as test fluids unless the saturated vapour being used is the one for which data are required.

5.2.2 Sound level sensor position

The sound level sensor shall be located 1 m from the nearest pipe surface. The downstream distance shall be a minimum of 1 m from the beginning of the exposed section of the test piping but not less than six nominal pipe diameters downstream of the test specimen outlet (see Figures 2a and 2b). Orientation of the sound level sensor with respect to the piping shall be in accordance with the requirements of the sound level meter manufacturer.

5.2.3 Blow-down test limitations

Blow-down test results are intended to simulate steady-state results. When using the blow-down method of testing, the blow-down rate shall be limited so that the time interval during which acoustical data are obtained shall be at least 10 times as long as the response time of the acoustical instrumentation. The blow-down rate shall be further limited so that the inlet pressure does not decay more than 2 % of the maximum inlet pressure during the time interval used to obtain acoustic data.

5.2.4 Test data accuracy

The accuracy of flow rate, pressure, travel, and temperature measurements shall conform to IEC 60534-2-3.

5.2.5 Test data

The following data and description of the test specimen, and equipment facility, shall be recorded.

1)	Upstream absolute pressure	kPa or bar
2)	Pressure differential and/or downstream pressure	kPa or bar
3)	Upstream fluid temperature	K
4)	Flow rate at reference conditions	m^3/h (see note), kg/s
5)	Barometric pressure	kPa or bar
6)	Relative travel	1
7)	Acoustic data:	dB or dB(A)
	The A-weighted sound pressure level and either the one-third-octave or full-octave band analysis shall be recorded for the frequency range 180 Hz (250 Hz octave band or 200 Hz one-third-octave band centre frequency) to 22 400 Hz (16 000 Hz octave band or 20 000 Hz one-third-octave band centre frequency). All measurements which are A-weighted shall be designated dB(A).	
8)	Description of the test specimen, including at least the following	
	a) nominal size of valve	
	b) description of fittings	
	c) description of flow direction	
	d) rated flow coefficient C (K_v or C_v)	Various (see IEC 60534-1)
	e) rated travel/opening angle	mm/deg
9)	Description of the test facility including	
	a) piping and instrumentation schematic	
	b) nominal pipe size and wall thickness	
	c) pipe material	
	d) description of environment chamber (if appropriate)	
	e) dimensional sketch of test facility	
10)	Description of test fluid, including one of the following:	
	a) molecular mass	kg/kmol
	b) density	kg/m^3
11)	Description of instruments	
12)	Sound level sensor position	m
13)	Flow coefficient C (K_v or C_v) at the test travel	Various (see IEC 60534-1)
14)	Pressure differential ratio factor of a control valve without attached fittings at choked flow, x_T	1
15)	Pressure differential ratio factor of a control valve with attached fittings at choked flow, x_{TP}	1
16)	Piping geometry factor, F_p	1
17)	Any deviation from this standard	

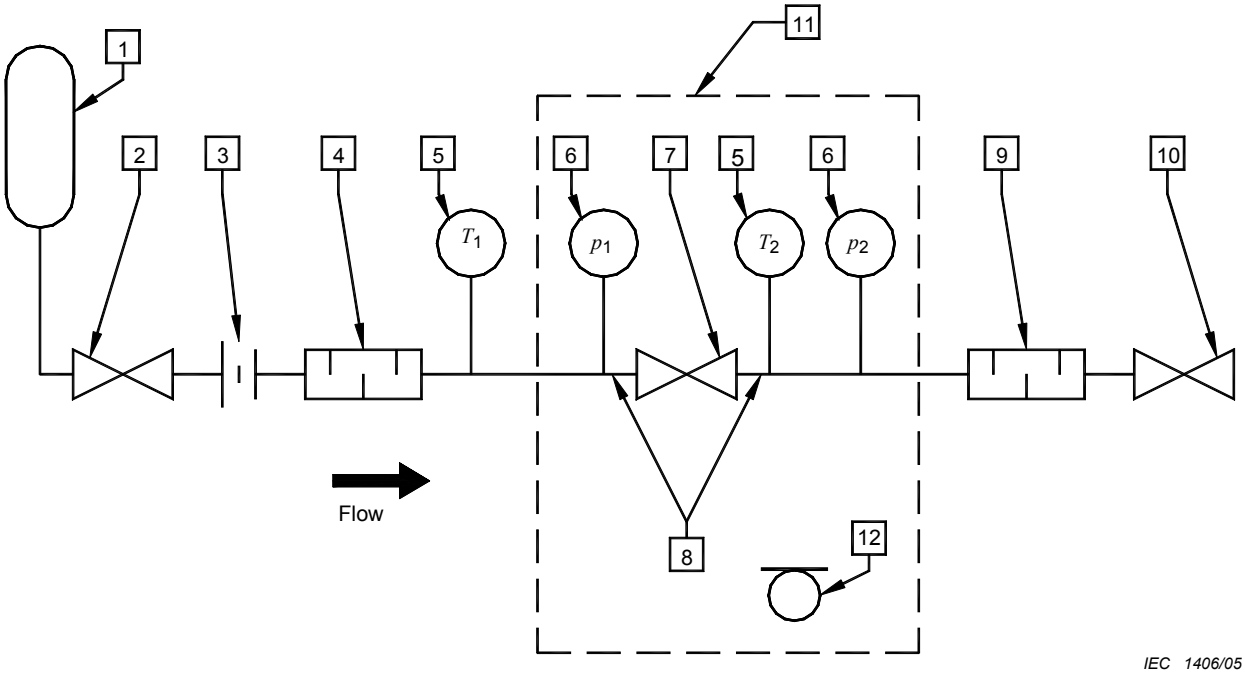
NOTE Volumetric flow rates in m^3/h refer to normal conditions, which are 101,325 kPa (1,01325 bar) and 273 K, or standard conditions, which are 101,325 kPa (1,01325 bar) and 288,6 K.

5.2.6 Accuracy

The overall accuracy of this method is limited to ±3 dB.

5.3 Data evaluation

The data shall be evaluated in accordance with IEC 60534-8-3.



NOTE See Figures 2a and 2b for placement of item 12 (sound level sensor) and item 11 (acoustic environment).

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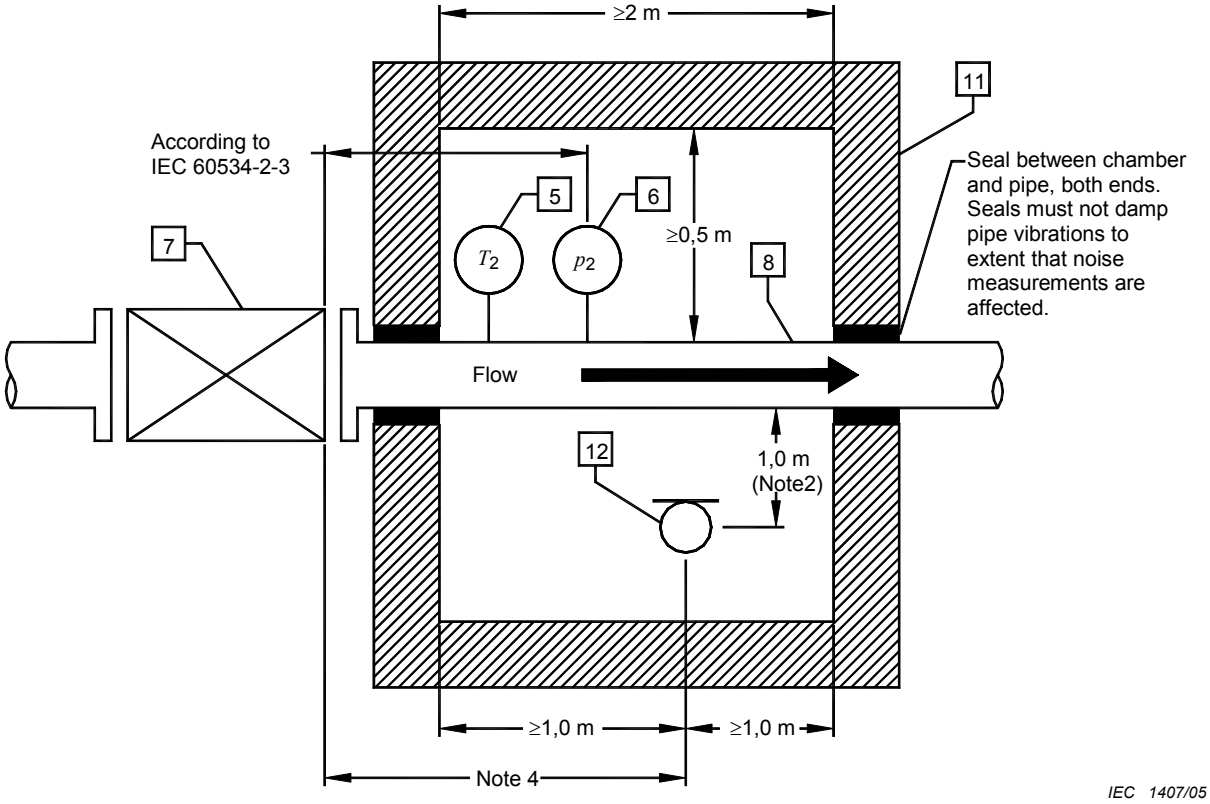
System components

1 Pressure source
2 Upstream throttling valve (if necessary)
3 Flow measuring device (location optional)
4 Upstream in-line silencer (if necessary)
5 Temperature measuring device
6 Pressure measuring device
7 Test specimen
8 Test section piping
9 Downstream in-line silencer (if necessary)
10 Downstream throttling valve (if necessary)
11 Acoustic environment (test chamber) (Note)
12 Sound level sensor (Note)

Figure 1 – Control valve noise test – System components



NOTE 1 D is the nominal pipe diameter of the outlet pipe, in mm

NOTE 2 The sound level sensor should be located at a distance of 1 m from the outer surface of the pipe and should be no closer than 0,5 m to the nearest chamber surface.

NOTE 3 The test section piping inside the test chamber should be continuous with no flanges, circumferential joints, or other pipe-wall reinforcements.

NOTE 4 For specimens 150 mm (6 in) and smaller, 1,0 m min. and 3,0 m max. Above 150 mm size, 6D min. and 20D max. should be held (see 5.2 for further clarification).

System components

5 Temperature measuring device

6 Pressure measuring device

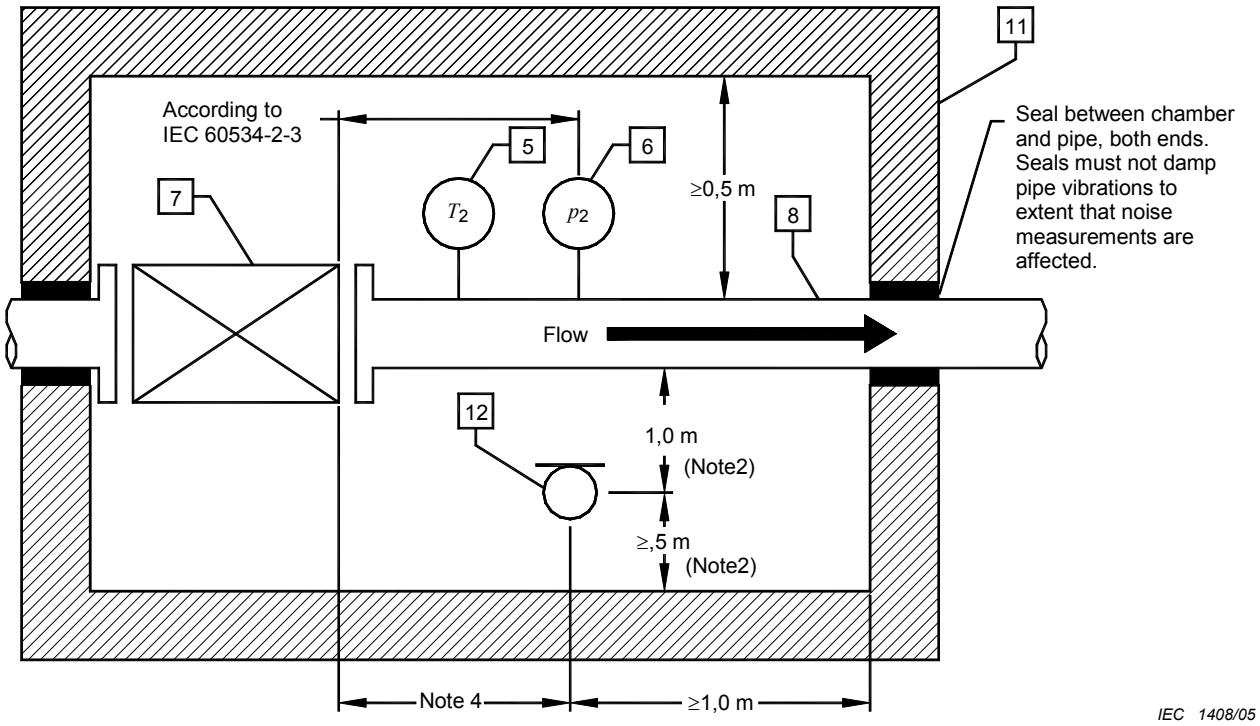
7 Test specimen

8 Test section piping (Note 3)

11 Acoustic environment (test chamber)

12 Sound level sensor (Note 2)

Figure 2a – Test specimen outside acoustic environment



NOTE 1 D is the nominal pipe diameter of the outlet pipe, in mm.

NOTE 2 The sound level sensor should be located at a distance of 1 m from the outer surface of the pipe and should be no closer than 0,5 m to the nearest chamber surface.

NOTE 3 The test section piping inside the test chamber should be continuous with no flanges, circumferential joints, or other pipe-wall reinforcements.

NOTE 4 For specimens 150 mm (6 in) and smaller, 1,0 m min. and 3,0 m max. Above 150 mm, 6D min. and 20D max. should be held (see 5.2 for further clarification).

System components

5 Temperature measuring device

6 Pressure measuring device

7 Test specimen

8 Test section piping (Note 3)

11 Acoustic environment (test chamber)

12 Sound level sensor (Note 2)

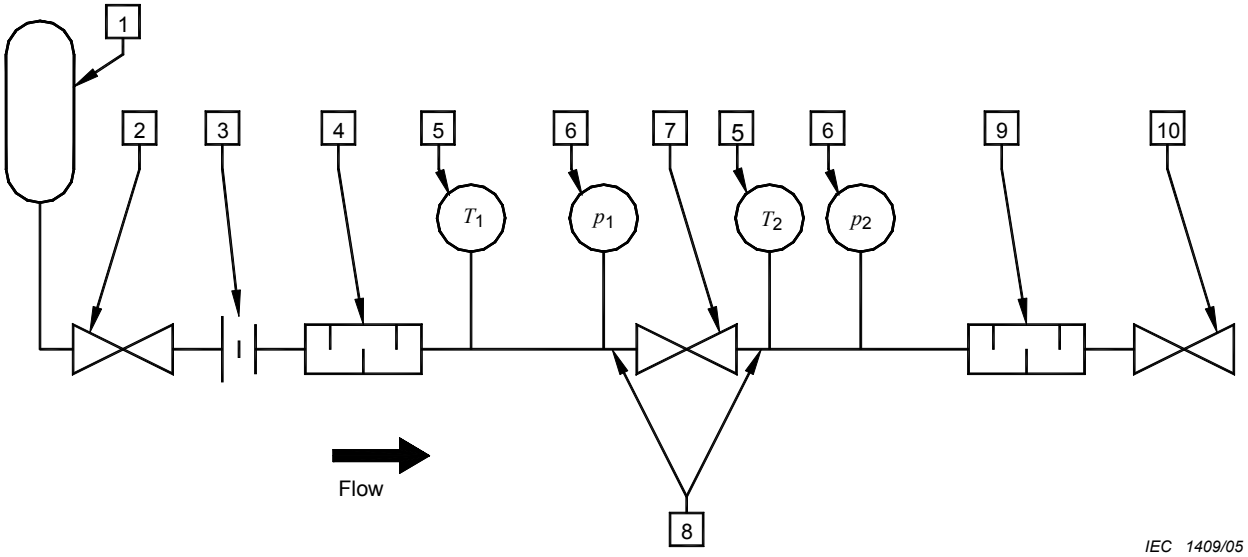
Figure 2b – Test specimen inside acoustic environment

Figure 2 – Test arrangements

6 Method B (internal sound pressure measurement)

6.1 Test system

The principle for the arrangement of a test stand for determining the internal sound power is shown in Figure 3.



System components

1 Pressure source
2 Upstream throttling valve (if necessary)
3 Flow measuring device (location optional)
4 Upstream in-line silencer (if necessary)
5 Temperature measuring device (optional)
6 Pressure measuring device
7 Test specimen
8 Test section piping
9 Downstream in-line silencer (if necessary)
10 Downstream throttling valve (if necessary)

Figure 3 – Arrangement of a test stand (principle)

The measuring arrangement and the equipment for measuring the parameters $\dot{m}$, T_1, p_1 and T_2, p_2 shall meet the requirements of IEC 60534-2-3.

The downstream silencer (9) shall be designed to avoid any increase of the measured noise due to sound power generated by the downstream pressure regulating valve 10, and to prevent any acoustic reflections of the noise created by the test specimen 7. The latter is fulfilled when the attenuation of the silencer reaches 15 dB in the frequency range considered.

6.1.1 Pressure regulating devices

The upstream and/or downstream pressure regulating devices are used to regulate the test pressures. Caution should be taken to avoid pressure drops which will create significant stream-borne or structure-borne noise. If such pressure drops are unavoidable, the use of silencers is recommended as shown in Figure 3. Flowmeters shall be installed in accordance with the manufacturer's instructions.

6.1.2 Test specimen

The test specimen and the test section shall not be insulated. However, separate tests may be conducted to determine the effects of pipe and/or valve insulation.

6.1.3 Test section piping

There is no limitation concerning the maximum length of downstream and upstream piping connected to the test specimen. The exposed downstream or upstream pipe within the acoustic environment shall be of a one-piece construction, i.e., no flanges, circumferential joints or other pipe-wall reinforcements.

Any mismatch between the inlet and outlet diameters of the test specimen and the inside diameter of the adjacent piping shall be minimized as far as practical. Non-insulated pipe shall be used.

The measuring location shall be within a distance of 6 to 10 times the internal nominal pipe diameter behind the outlet flange of the test specimen. If the upstream internal noise level is measured, the measuring location shall be within a distance of 6 to 10 times the internal nominal pipe diameter in front of the inlet flange of the test specimen. The measuring area S_i is the internal pipe cross-sectional area at the measuring location.

6.1.4 Pressure taps

Pressure taps shall be provided for the measurement of pressures. They shall conform to IEC 60534-2-3.

6.1.5 Number of measuring points

In accordance with the obtainable accuracy, one measuring point at the circumference of the measuring area is sufficient.

6.1.6 Instrumentation for noise measurement

The instrumentation used for sound pressure level measurement shall be in accordance with IEC 61672-1, Class 1 or Class 2. The octave filter used shall conform with IEC 61260.

The sound level sensor exposed to the fluid shall be suitable for the given operating conditions. For the measurement of pressures which deviate considerably from the normal air pressure, fast pressure sensors are recommended. The dynamic range of the pressure sensor arrangement (range between background noise and over-modulation) shall amount to at least 80 dB. The frequency range shall comprise 40 Hz (63 Hz octave band or 50 Hz one-third-octave band centre frequency) – 22 400 Hz (16 000 Hz octave band or 20 000 Hz one-third-octave band centre frequency) with an amplitude deviation of ±1 dB. Before and after each measuring procedure, the measuring system shall be tested by means of an acoustical calibrator.

NOTE Certain low-noise trims have peak frequencies exceeding 16 000 Hz. Verification that the peak frequency is within the measuring range of the sound level meter before processing the measured data is recommended. The peak frequency is that frequency at which the sound pressure level decays by at least 4 dB per octave above and below this frequency.

Additional instrumentation such as electronic recording devices and computers shall not cause errors in the measured data of more than ±1 dB.

6.2 Testing procedures

6.2.1 Test fluid

Air is the preferred fluid to be used in the test procedures. However, other compressible fluids may be substituted for air. The fluid shall be sufficiently dry to ensure that any icing which may take place does not affect the test results. Saturated vapours are not acceptable as test fluids unless the saturated vapour being used is the one for which data are required.

6.2.2 Fluid velocity

The mean (average) fluid velocity u through the measuring area shall be limited by selecting a suitable nominal pipe diameter in such a way that the noise level caused by disturbances in the boundary layer is at least 5 dB lower than the measured internal sound pressure level.

6.2.3 Background noise

Background noise or noise induced by the measuring system, or by the test stand itself, shall be at least 5 dB lower than the measured internal sound pressure level in the octave band range between 63 Hz and 16 000 Hz.

6.2.4 Sound level sensor position

The sound level sensor position shall be located within the measuring area. The tap for mounting the sound level sensor shall be at the upper part of the pipe for gases and vapours. The tap shall be even with the inner pipe wall to avoid secondary noise generation. See Figure 4.

NOTE If it is not possible to keep Δh less than 0,5 mm, the mismatch should be compensated either by means of a filling compound in a flat angle of <8° between the sound level meter and the pipe wall or by special shaping of the inner pipe wall.

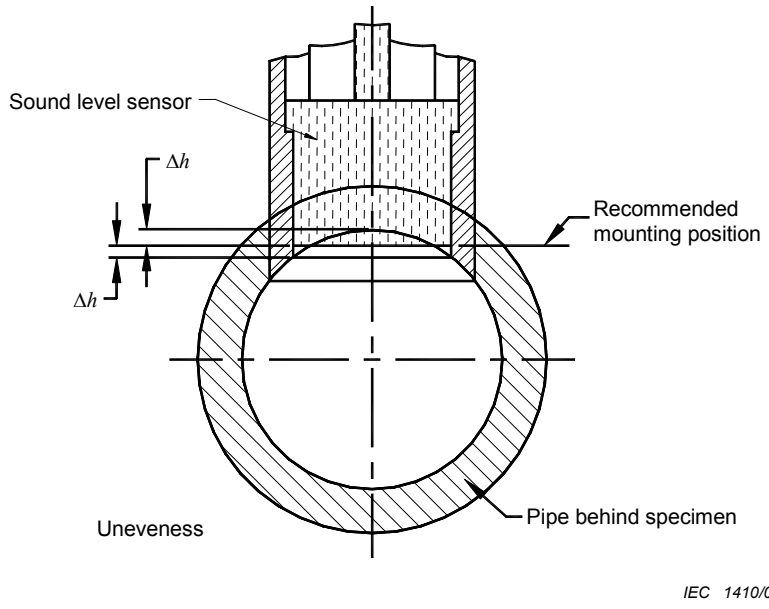


Figure 4 – Mounting position of the sound level meter in the pipe for Δh 0,5 mm

6.2.5 Blow-down test limitations

Blow-down test results are intended to simulate steady-state results. When using the blow-down method of testing, the blow-down rate shall be limited so that the time interval during which acoustical data are obtained shall be at least 10 times as long as the response time of the acoustical instrumentation. The blow-down rate shall be further limited so that the inlet pressure does not decay by more than 2 % of the maximum inlet pressure during the time interval used to obtain acoustic data.

6.2.6 Test data accuracy

The accuracy of flow rate, pressure, travel, and temperature measurements shall conform to IEC 60534-2-3.

6.2.7 Test data

For the determination of the acoustical characteristics, the pressure ratios x at the test specimen have to be widely varied. A range of x = 0,1 to 0,8 is recommended. The following data shall be recorded.

1)	Upstream absolute pressure	kPa or bar
2)	Pressure differential and/or downstream pressure	kPa or bar
3)	Upstream fluid temperature	K
4)	Downstream fluid temperature	K
5)	Flow rate at reference conditions	m^3/h (see note), kg/s
6)	Relative travel	1
7)	Acoustic data:	dB
	The unweighted sound pressure levels, L_{pi}, measured at one-third-octave bands, in the octave band range 63 Hz to 16 000 Hz	
8)	Description of the test specimen, including at least the following:	
	a) nominal size of valve	
	c) description of fittings	
	d) description of flow direction	
	e) rated flow coefficient C (K_v or C_v)	Various (see IEC 60534-1)
	f) rated travel/opening angle	mm/deg
9)	Description of the test facility including	
	a) piping and instrumentation schematic	
	b) nominal pipe size and wall thickness	
	c) pipe material	
	d) dimensional sketch of test facility	
10)	Description of test fluid, including one of the following:	
	a) molecular mass	kg/kmol
	b) density	kg/m^3
11)	Description of instruments	
13)	Flow coefficient C (K_v or C_v) at the test travel	Various (see IEC 60534-1)
14)	Pressure differential ratio factor of a control valve without attached fittings at choked flow, x_T	1

15)	Pressure differential ratio factor of a control valve with attached fittings at choked flow, x_{TP}	1
16)	Piping geometry factor, F_p	1
17)	Any deviation from this standard	

NOTE Volumetric flow rates in m^3/h refer to normal conditions, which are 101,325 kPa (1,01325 bar) and 273 K, or standard conditions, which are 101,325 kPa (1,01325 bar) and 288,6 K.

6.2.8 Accuracy

The overall accuracy of this method is limited to ±3 dB.

6.3 Data evaluation

The data shall be evaluated in accordance with IEC 60534-8-3.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

NOTE Where an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60534	Series	Industrial-process control valves	EN 60534	Series
IEC 60534-1	- [1)]	Part 1: Control valve terminology and general considerations	EN 60534-1	2005 [2)]
IEC 60534-2-3	- [1)]	Part 2-3: Flow capacity - Test procedures	EN 60534-2-3	1998 [2)]
IEC 60534-8-3	- [1)]	Part 8-3: Noise considerations - Control valve aerodynamic noise prediction method	EN 60534-8-3	2000 [2)]
IEC 61260	- [1)]	Electroacoustics - Octave-band and fractional-octave-band filters	EN 61260	1995 [2)]
IEC 61672-1	2002	Electroacoustics - Sound level meters Part 1: Specifications	EN 61672-1	2003
ISO 3744	1994	Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane	EN ISO 3744	1995
ISO 3745	2003	Acoustics - Determination of sound power levels of noise sources using sound pressure - Precision methods for anechoic and hemi-anechoic rooms	EN ISO 3745	2003

[1)] Undated reference.

[2)] Valid edition at date of issue.

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