SLOVENSKI STANDARD

SIST EN 60534-8-3:2001

01-april-2001

Industrial-prodess control valves - Part 8-3: Noise considerations - Control valve aerodynamic noise prediction method (IEC 60534-8-3:2000)

Industrial-process control valves -- Part 8-3: Noise considerations - Control valve aerodynamic noise prediction method

Stellventile für die Prozessregelung -- Teil 8-3: Geräuschbetrachtungen - Berechnungsverfahren zur Vorhersage der aerodynamischen Geräusche von Stellventilen

Vannes de régulation des processus industriels -- Partie 8-3: Considérations sur le bruit - Méthode de prédiction du bruit aérodynamique des vannes de régulation

Ta slovenski standard je istoveten z: **EN 60534-8-3:2000**

ICS:

17.140.20	Emisija hrupa naprav in opreme	Noise emitted by machines and equipment
23.060.40	Tlaļ ni regulatorji	Pressure regulators
25.040.40	Merjenje in krmiljenje industrijskih postopkov	Industrial process measurement and control

SIST EN 60534-8-3:2001 **en**

EUROPEAN STANDARD

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EN 60534-8-3

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Supersedes EN 60534-8-3:1995

English version

Industrial-process control valves
Part 8-3: Noise considerations - Control valve aerodynamic noise prediction method
(IEC 60534-8-3:2000)

Vannes de régulation des processus industriels
Partie 8-3: Considérations sur le bruit - Méthode de prédiction du bruit aérodynamique des vannes de régulation
(CEI 60534-8-3:2000)

Stellventile für die Prozessregelung
Teil 8-3: Geräuschbetrachtungen - Berechnungsverfahren zur Vorhersage der aerodynamischen Geräusche von Stellventilen
(IEC 60534-8-3:2000)

This European Standard was approved by CENELEC on 2000-08-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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 60534-8-3:2000 E

Foreword

The text of document 65B/400/FDIS, future edition 2 of IEC 60534-8-3, 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 60534-8-3 on 2000-08-01.

This European Standard supersedes EN 60534-8-3:1995.

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)	2001-05-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2003-08-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annex A is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60534-8-3:2000 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60534-2-1	NOTE: Harmonized as EN 60534-2-1:1998 (not modified).
IEC 60534-8-1	NOTE: Harmonized as EN 60534-8-1:2000 (not modified).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When 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	-	Series
IEC 60534-1	1987	Industrial-process control valves Part 1: Control valve terminology and general considerations	EN 60534-1	1993

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Vannes de régulation des processus industriels –

Partie 8-3:
Considérations sur le bruit –
Méthode de prédiction du bruit aérodynamique des vannes de régulation

Industrial-process control valves –

Part 8-3:
Noise considerations –
Control valve aerodynamic noise prediction method

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL-PROCESS CONTROL VALVES –

Part 8-3: Noise considerations – Control valve aerodynamic noise prediction method

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.

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International Standard IEC 60534-8-3 has been prepared by subcommittee 65B: Devices, of IEC technical committee 65: Industrial-process measurement and control.

This second edition of IEC 60534-8-3 cancels and replaces the first edition published in 1995. This second edition constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
65B/400/FDIS	65B/407/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annex A is for information only.

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

The mechanical stream power, as well as acoustical efficiency factors, are calculated for various flow regimes. These acoustical efficiency factors give the proportion of the mechanical stream power which is converted into internal sound power.

This method also provides for the calculation of the internal sound pressure and the peak frequency for this sound pressure, which is of special importance in the calculation of the pipe transmission loss.

At present, a common requirement by valve users is the knowledge of the sound pressure level outside the pipe, typically 1 m downstream of the valve or expander and 1 m from the pipe wall. This part of IEC 60534 offers a method to establish this value.

The equations in this part of IEC 60534 make use of the valve sizing factors as used in IEC 60534-1 and IEC 60534-2-1.

In the usual control valve, little noise travels through the wall of the valve. The noise of interest is only that which travels downstream of the valve and inside of the pipe and then escapes through the wall of the pipe to be measured typically at 1 m downstream of the valve body and 1 m away from the outer pipe wall.

Secondary noise sources may be created where the gas exits the valve outlet at higher Mach numbers. This method allows for the estimation of these additional sound levels which can then be added logarithmically to the sound levels created within the valve. See clauses 5 and 6 for Mach numbers up to 0,3 and clause 7 for Mach numbers greater than 0,3.

Although this prediction method cannot guarantee actual results in the field, it yields calculated predictions within 5 dB(A) for the majority of noise data from tests under laboratory conditions (reference IEC 60534-8-1).

The bulk of the test data used to validate the method was generated using air at moderate pressures and temperatures; however, it is believed that the method is generally applicable to other gases and vapours and at higher pressures. Uncertainties become greater as the fluid behaves less perfectly for extreme temperatures and for downstream pressures far different from atmospheric, or near the critical point. The equations include terms which account for fluid density and the ratio of specific heat.

NOTE Laboratory air tests conducted with up to 1 830 kPa (18,3 bar) upstream pressure and up to 1 600 kPa (16,0 bar) downstream pressure and steam tests up to 225 °C showed good agreement with the calculated values.

The transmission loss equations are based on a rigorous analysis of the interaction between the sound waves existing in the pipe and the many coincidence frequencies in the pipe wall. The wide tolerances in pipe wall thickness allowed in commercial pipe severely limit the value of the very complicated mathematical approach required for a rigorous analysis; therefore, a simplified method is used.

Example calculations are given in annex A.

This method is based on the IEC standards listed in clause 2 and the references given in the bibliography.

INDUSTRIAL-PROCESS CONTROL VALVES –

Part 8-3: Noise considerations – Control valve aerodynamic noise prediction method

1 Scope and limitations

This part of IEC 60534 establishes a theoretical method to predict the external sound-pressure level generated in a control valve and within adjacent pipe expanders by the flow of compressible fluids.

This method considers only single-phase dry gases and vapours and is based on the perfect gas laws.

This standard addresses only the noise generated by aerodynamic processes in valves and in the connected piping. It does not consider any noise generated by reflections, mechanical vibrations, unstable flow patterns and other unpredictable behaviour.

It is assumed that the downstream piping is straight for a length of at least 2 m from the point where the noise measurement is made.

This method is valid only for steel and steel alloy pipes (see equations (38) and (40) in 5.6).

The method is applicable to the following single-stage valves: globe (straight pattern and angle pattern), butterfly, rotary plug (eccentric, spherical), ball, and valves with cage trims. Specifically excluded are the full bore ball valves where the product F_pC exceeds 50 % of the rated flow coefficient.

For limitations on special low noise trims not covered by this standard, see 6.5. When the Mach number in the valve outlet exceeds 0,3 for standard trim or 0,2 for low noise trim, the procedure in clause 7 is used.

The Mach number limits in this standard are as follows:

Mach number location	Mach number limit		
	Clause 5 Standard trim	**Clause 6 Noise-reducing trim**	**Clause 7 High Mach number applications**
Freely expanded jet M_j	No limit	No limit	No limit
Valve outlet M_o	0,3	0,2	1,0
Downstream reducer inlet M_r	Not applicable	Not applicable	1,0
Downstream pipe M_2	0,3	0,2	0,8

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60534. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60534 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

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

3 Definitions

For the purpose of this part of IEC 60534, all of the definitions given in the IEC 60534 series apply, as well as the following:

3.1
acoustical efficiency
ratio of the stream power converted into sound power to the stream power of the mass flow

3.2
external coincidence frequency
frequency at which the external acoustic wavespeed is equal to the bending wavespeed in a plate of equal thickness to the pipe wall

3.3
internal coincidence frequency
lowest frequency at which the acoustic and structural axial wave numbers are equal for a given circumferential mode, thus resulting in the minimum transmission loss

3.4
fluted vane butterfly valve
butterfly valve which has flutes (grooves) on the face(s) of the disk. These flutes are intended to shape the flow stream without altering the seating line or seating surface

3.5
independent flow passage
flow passage where the exiting flow is not affected by the exiting flow from adjacent flow passages

3.6
peak frequency
frequency at which the internal sound pressure is maximum

3.7
valve style modifier F_d
ratio of the hydraulic diameter of a single flow passage to the diameter of a circular orifice, the area of which is equivalent to the sum of areas of all identical flow passages at a given travel

4 Symbols

Symbol	Description	Unit
A	Area of a single flow passage	m^2
A_n	Total flow area of last stage of multistage trim with *n* stages at given travel	m^2
C	Flow coefficient (K_v and C_v)	Various (see IEC 60534-1)
C_n	Flow coefficient for last stage of multistage trim with *n* stages	Various (see IEC 60534-1)
c_{vc}	Speed of sound in the *vena contracta* at subsonic flow conditions	m/s
c_{vcc}	Speed of sound in the *vena contracta* at critical flow conditions	m/s
c_2	Speed of sound at downstream conditions	m/s
D	Valve outlet diameter	m
d	Diameter of a flow passage (for other than circular, use d_H)	m
d_H	Hydraulic diameter of a single flow passage	m
d_i	Smaller of valve outlet or expander inlet internal diameters	m
D_i	Internal downstream pipe diameter	m
D_j	Jet diameter at the *vena contracta*	m
d_o	Diameter of a circular orifice, the area of which equals the sum of areas of all flow passages at a given travel	m
F_d	Valve style modifier	Dimensionless
F_L	Liquid pressure recovery factor of a valve without attached fittings (see note 4)	Dimensionless
F_{Ln}	Liquid pressure recovery factor of last stage of low noise trim	Dimensionless
F_{LP}	Combined liquid pressure recovery factor and piping geometry factor of a control valve with attached fittings (see note 4)	Dimensionless

F_p	Piping geometry factor	Dimensionless
f_g	External coincidence frequency	Hz
f_o	Internal coincidence pipe frequency	Hz
f_p	Generated peak frequency	Hz
f_{pR}	Generated peak frequency in valve outlet or reduced diameter of expander	Hz
f_r	Ring frequency	Hz
G_x, G_y	Frequency factors (see table 4)	Dimensionless
l	Length of a radial flow passage	m
l_w	Wetted perimeter of a single flow passage	m
L_{peR}	A-weighted sound-pressure level 1 m from pipe wall, caused by pipe expander-induced gas turbulence	dB(A) (ref P_o)
L_g	Correction for Mach number	dB (ref P_o)
L_{pAe}	A-weighted sound-pressure level external of pipe	dB(A) (ref P_o)
$L_{pAe,1m}$	A-weighted sound-pressure level 1 m from pipe wall	dB(A) (ref P_o)
L_{pi}	Internal sound-pressure level at pipe wall (see 5.6)	dB (ref P_o)
L_{piR}	Internal sound-pressure level in downstream pipe (see 7.2)	dB (ref P_o)
L_{pS}	Combined A-weighted sound-pressure level 1 m from pipe wall, caused by valve trim and expander	dB(A) (ref P_o)
L_{wi}	Total internal sound power level	dB (ref W_o)
M	Molecular mass of flowing fluid	kg/kmol
M_j	Freely expanded jet Mach number in regimes II to IV	Dimensionless
M_{jn}	Freely expanded jet Mach number of last stage in multistage valve with *n* stages	Dimensionless
M_{j5}	Freely expanded jet Mach number in regime V	Dimensionless
M_o	Mach number at valve outlet	Dimensionless
M_R	Mach number in the entrance to expander	Dimensionless
M_{vc}	Mach number at the *vena contracta*	Dimensionless
M_2	Mach number in downstream pipe	Dimensionless
$\dot{m}$	Mass flow rate	kg/s
$\dot{m}_s$	Mass flow rate at sonic velocity	kg/s
N	Numerical constants (see table 1)	Various
N_o	Number of independent and identical flow passages in valve trim	Dimensionless
p_a	Actual atmospheric pressure outside pipe	Pa (see note 3)