

Industrial-process control valves —

Part 8-4: Noise considerations — Prediction of noise generated by hydrodynamic flow

The European Standard EN 60534-8-4:2005 has the status of a
British Standard

ICS 23.060.40; 17.140.20; 25.040.40

National foreword

This British Standard is the UK implementation of EN 60534-8-4:2005. It is identical with IEC 60534-8-4:2005, incorporating corrigendum February 2006. It supersedes BS EN 60534-8-4:1994 which is withdrawn.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.

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

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**Industrial-process control valves
Part 8-4: Noise considerations -
Prediction of noise generated by hydrodynamic flow
(IEC 60534-8-4:2005)**

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des processus industriels
Partie 8-4: Considérations sur le bruit -
Prévision du bruit généré
par un écoulement hydrodynamique
(CEI 60534-8-4:2005)

Stellventile für die Prozessregelung
Teil 8-4: Geräuschbetrachtungen -
Vorausberechnung der Geräuschemission
für flüssigkeitsdurchströmte Stellventile
(IEC 60534-8-4:2005)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 65B/556/FDIS, future edition 2 of IEC 60534-8-4, 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 60534-8-4 on 2005-11-01.

This European Standard supersedes EN 60534-8-4:1994.

The noise prediction methods for hydrodynamic flow presented in this standard have been revised. The improvements are mainly in the acoustic efficiency factors for cavitating flow for single orifice, multi-stage and multi-hole trims and in the determination of transmission losses. This revised standard permits the prediction of the noise pressure levels by calculation without the need for coefficients determined by testing.

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) | 2006-08-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2008-11-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60534-8-4:2005 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

It is valuable to predict the noise levels that will be generated by valves. Safety requirements, such as occupational health standards, require that human exposure to noise be limited. There is also data indicating that noise levels above certain levels could lead to pipe failure or affect associated equipment (see IEC 60534-8-3). Earlier hydrodynamic noise standards relied on manufacturer test data and were neither generic nor as complete as desired.

A valve restricts flow by converting pressure energy into turbulence, heat and mechanical pressure waves in the containing valve body and piping. A small portion of this mechanical vibration is converted into acoustical energy. Most of the noise is retained within the piping system with only a small portion passing through the pipe wall downstream of the valve. Calculation of the energy involved is straightforward. The difficulties arise from determining first the acoustic efficiency of the mechanical energy to noise conversion and then the noise attenuation caused by the pipe wall.

INDUSTRIAL-PROCESS CONTROL VALVES –

Part 8-4: Noise considerations – Prediction of noise generated by hydrodynamic flow

1 Scope

This part of IEC 60534 establishes a method to predict the noise generated in a control valve by liquid flow and the resulting noise level measured downstream of the valve and outside of the pipe. The noise may be generated both by normal turbulence and by liquid cavitation in the valve. Parts of the method are based on fundamental principles of acoustics, fluid mechanics, and mechanics. The method is validated by test data. Noise generated by flashing flow is not considered in this standard.

The transmission loss (TL) equations are based on analysis of the interaction between the sound waves inside the pipe and the coincidence frequencies in the wall of the pipe taking into account that commercial pipe tolerances allow a relatively wide variation in the thickness of the pipe wall. Ideal straight piping is assumed.

The method can be used with all conventional control valve styles including globe, butterfly, cage-type, eccentric rotary, and modified ball valves. Tests so far have only been conducted with water. The applicability of this method for fluids other than water is not known at this time.

This standard considers only noise generated by hydraulic turbulence and fluid cavitation. It does not consider any noise that might be generated by mechanical vibrations, unstable flow patterns, and unpredictable behaviour. In the typical installation, very little noise travels through the wall of the control valve body. The noise is measured at the standard measuring point of 1 m downstream of the valve and 1 m away from the outer surface of the pipe.

This prediction method has been validated with test results based on water covering more than 90 % of all known valve types at inlet pressures of up to 15 bar. This method is considered accurate within $\pm 5\text{dB(A)}$ except in the range of $x_F = x_{Fz} \pm 0,1$, when x_{Fz} is calculated using equations (3a) or (3b).

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 60534-8-2, *Industrial-process control valves – Part 8: Noise considerations – Section 2: Laboratory measurement of noise generated by hydrodynamic flow through control valves*

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

3 Symbols

Symbol	Description	Unit
$A(f)$	Frequency-dependent A-weighting value	dB(A) (ref P_0)
c_L	Speed of sound in liquid	m/s
c_o	Speed of sound in air = 343	m/s
c_p	Speed of sound in pipe (for steel pipe 5 000)	m/s
C	Flow coefficient (K_v and C_v)	Various (see IEC 60534-1)
C_R	Flow coefficient (K_v and C_v) at rated travel	Various (see IEC 60534-1)
C_1	Flow coefficient of first stage in a multistage valve (K_v and C_v)	Various (see IEC 60534-1)
C_n	Flow coefficient of last stage in a multistage valve (K_v and C_v)	Various (see IEC 60534-1)
D_i	Internal pipe diameter	m
D_j	Jet diameter	m
d	Valve inlet internal diameter	m
d_H	Multihole trim hole diameter	m
d_o	Seat or orifice diameter	m
F_{cav}	Frequency distribution function (cavitating)	Dimensionless
F_d	Valve style modifier	Dimensionless
F_L	Liquid pressure recovery factor of a valve without attached fittings	Dimensionless
F_{Ln}	Liquid pressure recovery factor of the last throttling stage	Dimensionless
F_{turb}	Frequency distribution function (turbulent)	Dimensionless
f	Frequency	Hz
f_{ji}	Octave band frequency	Hz
f_r	Ring frequency	Hz
$f_{p,turb}$	Internal peak sound frequency (turbulent)	Hz
$f_{p,cav}$	Internal peak sound frequency (cavitating)	Hz
$L_{pe,1m}$	Overall external sound pressure level 1 m from pipe wall	dB (ref P_0)
$L_{pAe,1m}$	A-weighted overall external sound pressure level 1 m from pipe wall	dB(A) (ref P_0)
$L_{pAe,1m,i}$	A-weighted external sound pressure level 1 m from pipe wall of stage i (number i from 1... n) in multistage valve with n stages	dB(A) (ref P_0)
L_{pi}	Overall internal sound pressure level at pipe wall	dB (ref P_0)
$L_{pi}(f_i)$	Frequency-dependent internal sound pressure level	dB (ref P_0)
$\dot{m}$	Mass flow rate	kg/s

n	Number of stages in multistage trim	Dimensionless
N	Numerical constants (see Table 1)	Various
N_0	Number of independent and identical flow passages in valve trim or throttling stage	Dimensionless
N_{STR}	Strouhal number of jet	Dimensionless
P_a	Reference pressure = 1×10^5	Pa
P_0	Reference sound pressure = 2×10^{-5}	Pa
p_1	Valve inlet absolute pressure	Pa
p_2	Valve outlet absolute pressure	Pa
$p_{1,i}$	Inlet absolute pressure of stage i (number i from 1... n) in multistage valve with n stages	Pa
$p_{2,i}$	Outlet absolute pressure of stage i (number i from 1... n) in multistage valve with n stages	Pa
p_v	Vapour pressure of liquid	Pa
Δp	Pressure differential	Pa
Δp_c	Pressure differential for U_{vc} calculation	Pa
r_W	Acoustic power ratio	Dimensionless
t_p	Pipe-wall thickness	m
TL	Transmission loss	dB
TL_{cav}	Overall transmission loss at cavitating conditions	dB
$\Delta TL_{fp,turb}$	Transmission loss corrected for frequency $f_{p,turb}$	dB
TL_{turb}	Overall transmission loss at turbulent conditions	dB
TL_{fr}	Transmission loss at ring frequency f_r	dB
U_{vc}	<i>Vena contracta</i> velocity	m/s
W_a	Sound power	W
W_m	Mechanical stream power	W
x_F	Differential pressure ratio	Dimensionless
x_{FZ}	Differential pressure ratio of incipient cavitation noise with inlet pressure of 6×10^5 Pa	Dimensionless
x_{Fzp1}	Differential pressure ratio corrected for inlet pressure	Dimensionless
η_{turb}	Acoustic efficiency factor (turbulent)	Dimensionless
η_{cav}	Acoustic efficiency factor (cavitating)	Dimensionless
ρ	Density	kg/m ³
ρ_0	Density of air = 1,293	kg/m ³
ρ_p	Density of pipe material (= 7 800 for steel)	kg/m ³
ρ_L	Density of liquid	kg/m ³
cav	Cavitation	
turb	Turbulent	
i	Pipe internal or counter index	
p	Pipe	
vc	<i>Vena contracta</i>	