SLOVENSKI STANDARD
SIST EN ISO 14163:1999

01-november-1999

Akustika - Smernice za varstvo pred hrupom z dušilniki (ISO 14163:1998)

Acoustics - Guidelines for noise control by silencers (ISO 14163:1998)

Akustik - Leitlinien für den Schallschutz durch Schalldämpfer (ISO 14163:1998)

Acoustique - Lignes directrices pour la réduction du bruit au moyen de silencieux (ISO 14163:1998)

Ta slovenski standard je istoveten z: EN ISO 14163:1998

ICS:

17.140.01	Akustična merjenja in blaženje hrupa na splošno	Acoustic measurements and noise abatement in general

SIST EN ISO 14163:1999 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 14163

October 1998

ICS 17.140.01

Descriptors: see ISO document

English version

Acoustics - Guidelines for noise control by silencers (ISO 14163:1998)

Acoustique - Lignes directrices pour la réduction du bruit au moyen de silencieux (ISO 14163:1998)

Akustik - Richtlinien für den Schallschutz durch Schalldämpfer (ISO 14163:1998)

This European Standard was approved by CEN on 21 September 1998.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN ISO 14163:1998 E

Foreword

The text of the International Standard ISO 14163:1998 has been prepared by Technical Committee ISO/TC 43 "Acoustics" in collaboration with Technical Committee CEN/TC 211 "Acoustics", the secretariat of which is held by DS.

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of an identical text or by endorsement, at the latest by April 1999, and conflicting national standards shall be withdrawn at the latest by April 1999.

NOTE FROM CEN/CS: The foreword is susceptible to be amended on reception of the German language version. The confirmed or amended foreword, and when appropriate, the normative annex ZA for the references to international publications with their relevant European publications will be circulated with the German version.

Endorsement notice

The text of the International Standard ISO 14163:1998 was approved by CEN as a European Standard without any modification.

INTERNATIONAL STANDARD

ISO 14163

First edition
1998-10-15

Acoustics — Guidelines for noise control by silencers

Acoustique — Lignes directrices pour la réduction du bruit au moyen de silencieux

Reference number
ISO 14163:1998(E)

Contents

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 14163 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

Annexes A to C of this International Standard are for information only.

Introduction

Whenever airborne sound cannot be controlled at the source, silencers provide a powerful means of sound reduction in the propagation path. Silencers have numerous applications and different designs based on various combinations of absorption and reflection of sound, as well as on reaction on the sound source. This International Standard offers a systematic description of principles, performance data and applications of silencers.

Acoustics — Guidelines for noise control by silencers

1 Scope

This International Standard deals with the practical selection of silencers for noise control in gaseous media. It specifies the acoustical and operational requirements which are to be agreed upon between the supplier or manufacturer and the user of a silencer. The basic principles of operation are described in this International Standard, but it is not a silencer design guide.

The silencers described are suitable, among others,

— for attenuating system noise and preventing crosstalk in heating, ventilation and air-conditioning (HVAC) equipment;

— for preventing or reducing sound transmission through ventilation openings from rooms with high inside sound levels;

— for attenuating blow-off noise generated by high-pressure lines;

— for attenuating intake and exhaust noise generated by internal combustion engines; and

— for attenuating intake and outlet noise from fans, compressors and turbines.

They are classified according to their types, performance characteristics and applications. Active and adaptive passive noise-control systems are not covered in detail in this International Standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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.

ISO 3741, *Acoustics — Determination of sound power levels of noise sources using sound pressures — Precision methods for reverberation rooms.*

ISO 3744, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for free-field conditions over a reflecting plane.*

ISO 7235, *Acoustics — Measurement procedures for ducted silencers — Insertion loss, flow noise and total pressure loss*.

ISO 11691, *Acoustics — Measurement of insertion loss of ducted silencers without flow — Laboratory survey method.*

ISO 11820, *Acoustics — Testing of silencers in situ.*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
silencer
device reducing sound transmission through a duct, a pipe or an opening without preventing the transport of the medium

3.2
dissipative silencer
absorptive silencer
silencer providing for broad-band sound attenuation with relatively little pressure loss by partially converting sound energy to heat through friction in porous or fibrous duct linings

3.3
reactive silencer
general term for reflective and resonator silencers where the majority of the attenuation does not involve sound energy dissipation

3.4
reflective silencer
silencer providing for single or multiple reflections of sound by changes in the cross-section of the duct, duct linings with resonators, or branchings to duct sections with different lengths

3.5
resonator silencer
silencer providing for sound attenuation at weakly damped resonances of elements

NOTE The elements may or may not contain absorbent material.

3.6
blow-off silencer
silencer used in steam blow-off and pressure release lines throttling the gas flow by a considerable pressure loss in porous material and providing sound attenuation by lowering the flow velocity at the exit and reacting on the source of the sound (such as a valve)

3.7
active silencer
silencer providing for the reduction of sound through interference effects by means of sound generated by controlled auxiliary sound sources

NOTE Mostly low-order modes of sound in ducts are affected.

3.8
adaptive passive silencer
silencer with passive sound-attenuating elements dynamically tuned to the sound field

3.9
insertion loss,
D_i
difference between the levels of the sound powers propagating through a duct or an opening with and without the silencer

NOTE 1 The insertion loss is expressed in decibels, dB.

NOTE 2 Adapted from ISO 7235.

3.10
insertion sound pressure level difference

D_{ip}

difference between the sound pressure levels occurring at an immission point, without a significant level of extraneous sound, without and with the silencer installed

NOTE 1 The insertion sound pressure level difference is expressed in decibels, dB.

NOTE 2 Adapted from ISO 11820.

3.11
transmission loss

D_t

difference between the levels of the sound powers incident on and transmitted through the silencer

NOTE 1 The transmission loss is expressed in decibels, dB.

NOTE 2 For standard test laboratories D_t equals D_i, whereas results for D_t and D_i obtained from *in situ* measurements may often differ due to limited measurement possibilities.

NOTE 3 Adapted from ISO 11820.

3.12
discontinuity attenuation

D_s

that portion of the insertion loss of a silencer or silencer section due to discontinuities

NOTE The discontinuity attenuation is expressed in decibels, dB.

3.13
propagation loss

D_a

decrease in sound pressure level per unit length which occurs in the midsection of a silencer with constant cross-section and uniform longitudinal design, characterizing the longitudinal attenuation of the fundamental mode

NOTE The propagation loss is expressed in decibels per metre, dB/m.

3.14
outlet reflection loss

D_m

difference between the levels of the sound power incident on and transmitted through the open end of a duct

NOTE The outlet reflection loss is expressed in decibels, dB.

3.15
modes

spatial distributions (or transverse standing wave patterns) of the sound field in a duct that occur independently from one another and suffer a different attenuation

NOTE The fundamental mode is least attenuated. In narrow and in lined ducts, higher-order modes suffer substantially higher attenuation.

3.16
cut-on frequency

lower frequency limit for propagation of a higher-order mode in a hard-walled duct

NOTE 1 The cut-on frequency is expressed in hertz, Hz.

NOTE 2 In a duct of circular cross-section, the cut-on frequency for the first higher-order mode is $f_{cC} = 0{,}57c/C$ where c is the speed of sound and C is the duct diameter. In a rectangular duct with larger dimension H, $f_{cH} = 0{,}5c/H$.

3.17
pressure loss
Δp_t
difference between the mean total pressures upstream and downstream of the silencer

NOTE 1 The pressure loss is expressed in pascals, Pa.

NOTE 2 Adapted from ISO 7235.

3.18
regenerated sound
flow noise
flow noise caused by the flow conditions in the silencer.

NOTE Sound power levels of regenerated sound and pressure losses measured in laboratory tests are related to a laterally uniform flow distribution at the inlet of the silencer. If this uniform flow distribution is not attainable under *in situ* conditions, for example because of the upstream duct design, higher levels of regenerated sound and higher pressure losses will occur.

4 Specification, selection and design considerations

4.1 Requirements to be specified

4.1.1 In general, the sound pressure level (A-weighted, one-third-octave or full-octave) shall not exceed a specified value at a specified position (e.g. at a work station, in the neighbourhood, or in a recreation room). The permissible contribution from a sound source can then be determined in terms of the sound power level and the directivity index of that source using sound propagation laws and requirements concerning the allocation of contributions to several partial sound sources. The required insertion loss of the silencer is given by the difference between the permissible and the actual sound power level of the source.

In simple cases where the sound immission is determined solely by the sound source to be attenuated, the necessary insertion sound pressure level difference of the silencer can be calculated directly from the difference between the permissible and the actual sound pressure level at the immission point. When the difference in directivity indices with and without the silencer is negligible, the insertion sound pressure level difference equals the insertion loss of the silencer.

4.1.2 The permissible pressure loss shall not be exceeded.

NOTE This requirement should be specified as clearly as possible. Instead of the imprecise specification "as small as possible", a sensible limit value has to be found. Even if the pressure loss is considered as "not critical", a limit value should be determined from the maximum permissible flow velocity that may not be exceeded for reasons of mechanical stability, regenerated sound or energy consumption costs.

4.1.3 The permissible size of the silencer shall be kept as small as possible (for reasons of cost and weight).

NOTE There is a minimum size which (given the state of the art) cannot be reduced. This size depends on the required reduction in sound level, the permissible pressure loss and on other restrictions concerning materials to be used (or avoided), resistance to different kinds of stress, etc.

4.1.4 Additional requirements (concerning materials, durability, leakages, etc.) result from the application of the silencer in hot, dusty, humid or aggressive gases, in pressure lines or for high sound pressure levels and vibration levels, and from the combination of silencers with devices for the control of exhaust gas, sparks and particles.

4.2 Selection and layout of silencers

Specific information on silencers can be drawn from

— laboratory measurements made in accordance with ISO 7235;

— silencer manufacturers' test data;

— theoretical models to calculate propagation loss and insertion loss for silencers with circular or rectangular cross-section;

— pressure loss and regenerated sound prediction methods.

The selection of a dissipative, a reactive or a blow-off silencer will be determined by its application or by reference to the experience presented in this International Standard.

Results obtained from computer programs for the insertion loss of dissipative silencers depend on the assumptions made concerning the magnitude and distribution of airflow resistance in the silencer and the acoustical effect of the cover [18]. Certain geometrical features like off-setting of splitters or subdividing of absorbers are not easily accessible for calculation. Calculations are most accurate for parameter variations concerning design as well as operating conditions. Effects of flow on the performance of reactive silencers are taken into account by special highly sophisticated computer software.

4.3 Design of special silencers

The design of a special silencer is usually an iterative process featuring the following stages:

a) rough specification of the dimensions of free ducts for the flow and of connected spaces for the distribution of sound, for example using the manufacturers' declarations for similar silencers and taking into account the essential requirements and restrictions;

b) construction of a model for predictive calculation or measurements;

c) use of the model and comparison of the results with requirements concerning sound level reduction and pressure loss;

d) change of dimensions and sound-absorbent materials to fulfil requirements or to optimize the design;

e) constructional consideration of special requirements.

5 Types of silencers, general principles and operational considerations

5.1 Overview

Silencers are used to

— prevent pulsations and oscillations of the gas at the source,

— reduce conversion of the pulsations and oscillations into sound energy, and

— provide conversion of sound energy into heat.

Table 1 — Typical advantages and shortcomings of different types of silencers

Type of silencer	Advantages	Shortcomings
Dissipative silencer	Broad-band attenuation, little pressure loss	Sensitive to contamination and mechanical destruction
Reactive silencers:		
Resonator type	Tuned attenuation, insensitive to contamination	Narrow-band attenuation, sensitive to flow
Reflective type	Robust element, application for large pressure pulsations, high sound levels, contaminated flow, strong mechanical vibrations	Greater pressure loss, acoustic pass bands (frequency bands with little or no attenuation), flow sensitivity of acoustical performance