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ISO TC 43/SC 1~~/WG 66~~

2023-xx

Secretariat: DIN

Acoustics — Acoustic insulation for pipes, valves and flanges

Acoustique — Isolation acoustique des tuyaux, clapets et brides

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Contents

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC-_Directives, Part-_1. In particular, the different approval criteria needed for the different types of ISO ~~documents~~ document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC-_Directives, Part-_2 (see ~~www.iso.org/directives~~www.iso.org/directives).

~~Attention is drawn~~ISO draws attention to the possibility that ~~some of~~ the ~~elements~~implementation of this document may ~~be~~involve the ~~subject~~use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights. ~~ISO~~ in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights. ~~Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).~~

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO-_specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see ~~www.iso.org/iso/foreword.html~~www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 15665:2003), which has been technically revised.

The main changes are as follows:

— addition of Class D2 and D3 Insertion Loss from Shell DEP 31.46.00.31 to expand the purview of this document;

— addition of new pipe sound sources to incorporate pneumatic pumps and solid pellet conveyors;

— updates to Clause 6 relating to insulation construction and system material components to incorporate newer technologies and materials;

— change of previous Clause 9: "*Acoustic insulation constructions that meet the insulation class requirements*" into Annex A to update and expand the use of various, newer material system

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constructions. Additional emphasis placed on the requirement for insertion loss testing, as defined in this standard, for determining acoustic performance of pipework insulation systems

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at ~~www.iso.org/members.html~~www.iso.org/members.html.

Acoustics — Acoustic insulation for pipes, valves and flanges

1 Scope

This document defines the acoustic performance of four classes (Classes A, B, C and D) of pipe insulation. It also defines a standardized test method for measuring the acoustic performance of any type of material system construction, thereby allowing existing and new insulation constructions to be rated against the four classes. Furthermore, this document presents some typical types of construction that would be expected to meet these acoustic performance classes.

This document is applicable to the acoustic insulation of cylindrical steel pipes and to their piping components. It is valid for pipes up to 1 m in diameter and a minimum wall thickness of 4,2 mm for diameters below 300 mm, and 6,3 mm for diameters from 300 mm and above. It is not applicable to the acoustic insulation of rectangular ducting and vessels or machinery.

This document covers both design and installation aspects of acoustic insulation and provides guidance to assist noise control engineers in determining the required class and extent of insulation needed for a particular application. It gives typical examples of construction methods, but the examples are for information only and not meant to be prescriptive.

This document emphasises the aspects of acoustic insulation that are different from those of thermal insulation, serving to guide both the installer and the noise control engineer. Details of thermal insulation are beyond the scope of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

~~<std>~~ISO 354, *Acoustics — Measurement of sound absorption in a reverberation room*~~</std>~~

~~<std>~~ISO 3741:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms*~~</std>~~

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at ~~https://www.iso.org/obp~~https://www.iso.org/obp

— IEC Electropedia: available at ~~https://www.electropedia.org/~~https://www.electropedia.org/

3.1
piping
cylindrical pipes and fittings such as valves, flanges, bellows and supports

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Note 1 to entry: Piping is a pipe, or a system of pipes used to convey fluids (solids, liquid or gas) from one location to another. Piping fittings: Fittings are used in pipe systems to connect straight sections of pipe and adapt to different sizes or shapes.

3.2
acoustic insulation
acoustic lagging
outer cover applied with the aim of reducing the noise radiated from the pipe

Note 1 to entry: Acoustic insulation/acoustic lagging typically consists of a sound-absorbing and/or resilient material ("porous layer") on the piping and an impermeable outer cover ("cladding"). The term "insulation" used for the remainder of this standard refers to insulation and to lagging, which are both considered to be the same thing.

3.3
airflow resistivity
pressure drop per unit thickness of a porous material encountered by a steady air flow of unit velocity through the material

Note 1 to entry: Airflow resistivity equals the pressure drop divided by the product of the air velocity and the thickness of the sample.

Note 2 to entry: The unit of airflow resistivity is N s/m^4 = Pa s/m^2.

Note 3 to entry: Procedures for determining the flow resistivity are described in ISO 9053-1 and ISO 9053-2.

3.4
insertion loss
sound power insulation
D_W
difference in the sound power level radiated from a noise source before and after the application of the acoustic insulation for any octave or one-third-octave band

Note 1 to entry: Insertion loss is measured in decibels.

Note 2 to entry: See Notes to entry 2~~&~~ and 4 to 3.5.

3.5
sound pressure insulation
D_p
difference in the sound pressure level, at a specified position relative to the noise source, before and after the application of the acoustic insulation for any octave or one-third-octave band

Note 1 to entry: Sound pressure insulation is measured in decibels.

Note 2 to entry: For noise sources located indoors, especially for laboratory measurements, the determination of sound power insulation ~~D_W~~, D_W, is most appropriate. ~~D_W~~ D_W can be determined in a reverberation room or with sound intensity measurements. Sound intensity measurements can also be used to obtain ~~D_W~~ D_W in the field. Methodology for determining sound power using sound intensity should refer to ISO 9614 ~~parts~~ -1 or ISO 9614-2 as is most appropriate.

Note 3 to entry: For piping outdoors in field situations, the determination of sound pressure insulation ~~D_P~~, D_p, is less accurate but can be a more practical approach provided extraneous noise sources do not significantly impinge upon the measurements. The sound pressure measurement positions should be selected in relation to the design goal of the acoustic insulation, which will in general be in a circle around the piping. It is preferable to use a

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measurement distance of 1 m from the pipe surface, or 2,5 times the pipe diameter for pipes less than or equal to 0,33 m in diameter, to minimize near field measurement effects.

Note 4 to entry: The measurement positions and plant operational conditions for determination of D_W D_W or D_P D_p should be the same with and without the acoustic insulation. If the radiation patterns of both the untreated and acoustical insulated piping are "cylindrical omni-directional", the two measures (D_W and D_P)(D_W and D_p) yield the same result.

3.6
anechoic termination

non-reflecting acoustic assembly located at the end of a pipe or duct, which transforms a pipe or duct of finite length into an acoustically infinite long pipe/duct, specifically for in-pipe/duct aero-acoustic measurements

4 Classes of acoustic insulation

This clause defines four classes of acoustic insulation or acoustic lagging, denoted Classes A, B, C and D, in terms of requirements for minimum insertion loss. The minimum insertion loss is specified in Table 1 and illustrated in Figures 1 to 4. Formulae for the approximate calculations of the required insertion loss (within 0,5 dB) are presented in Annex B.

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The insertion loss of acoustic insulation or acoustic lagging is related to the diameter of the pipe on which it is applied. The pipe diameters are divided into three pipe size groups and the insulation class will consist of a letter/number combination indicating the diameter on which the insulation is applied.

The pipe sizes used are:

— less than 300 mm outside diameter;

— greater than or equal to 300 mm but less than 650 mm;

— greater than or equal to 650 mm diameter but less than 1 000 mm.

Table 1 — Minimum insertion loss required for each class

Class	**Range of nominal diameter** D mm	**Octave band centre frequency**, Hz 125	250	500	1 000	2 000	4 000	8 000
		Minimum insertion loss D_w D_W, dB						
A1	D < 300	-4	-4	2	9	16	22	29
A2	300 ≤ D < 650	-4	-4	2	9	16	22	29
A3	650 ≤ D < 1 000	-4	2	7	13	19	24	30
B1	D < 300	-9	-3	3	11	19	27	35
B2	300 ≤ D < 650	-9	-3	6	15	24	33	42
B3	650 ≤ D < 1 000	-7	2	11	20	29	36	42
C1	D < 300	-5	-1	11	23	34	38	42
C2	300 ≤ D < 650	-7	4	14	24	34	38	42
C3	650 ≤ D < 1 000	1	9	17	26	34	38	42
D2	300 ≤ D < 650	-3	4	15	36	45	45	45

D3	650 ≤ D < 1 000	3	9	26	36	45	40	40

In order to conform to a given class, the insertion loss of all seven octave bands shall exceed or be equal to the levels specified. An acoustic insulation that does not fully satisfy the above requirement shall be designated as “unclassified”.

Acoustic insulation will reduce the noise radiated directly from the pipe but there is a counteracting effect: for radiation of any residual vibrations as the insulation cladding has a larger radiating area than the surface area of the bare pipe. Furthermore, the cladding can have a higher radiation efficiency than the pipe, at low frequencies. These effects are relatively more important on small diameter pipes and pose a limit to the applicability of the various classes of insulation.

Acoustic insulation will also exhibit a resonance at low frequency due to the mass of the cladding and the spring action of the trapped air and the porous layer. The resonance frequency in hertz, if the mechanical stiffness contribution of the porous material is low, is approximately given by Formula (1):

$$f_0 = \frac{60}{\sqrt{m''d}} \quad f_0 = \frac{60}{\sqrt{m''d}} \qquad (1)$$

where

m'' is the numerical value of the mass per unit area of the cladding, expressed in kilograms per square metre,

d is the numerical value of the distance between the tube wall and the cladding, expressed in metres.

The insertion loss of the acoustic insulation is expected to be negative for frequencies below 1,4 f_0.

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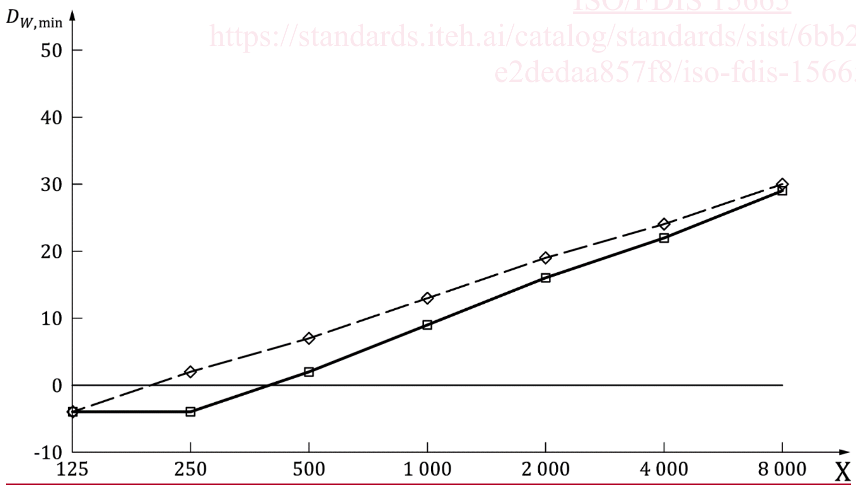

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Field Code Changed

X	octave band centre frequency in Hz	15665_ed2fig1_key1.EPS	Classes A1 and A2
$D_{W,\text{min}}$ $D_{W,\text{min}}$	minimum insertion loss in dB	15665_ed2fig1_key2.EPS	Class A3

Figure 1 — Minimum insertion loss required for Class A

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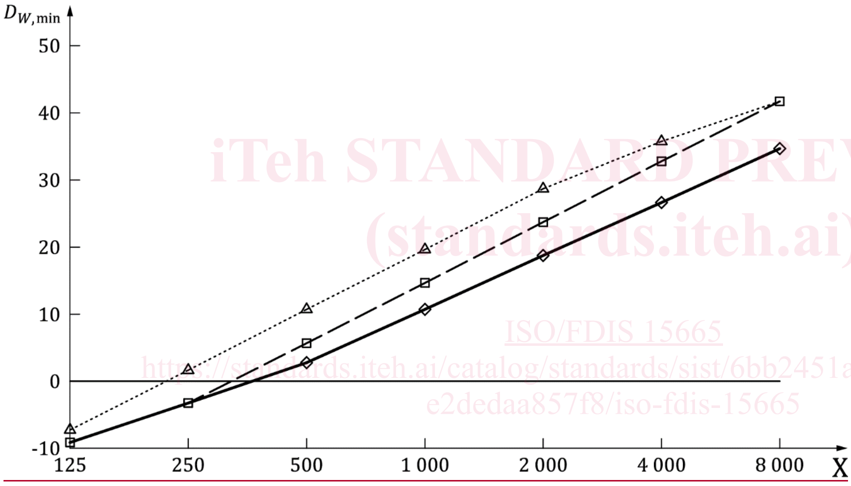

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X	octave band centre frequency in Hz	15665_ed2fig2_key1.EPS	Class B1
$D_{W,\text{min}}$ $D_{W,\text{min}}$	minimum insertion loss in dB	15665_ed2fig2_key2.EPS	Class B2
		15665_ed2fig2_key3.EPS	Class B3

Figure 2 — Minimum insertion loss required for Class B

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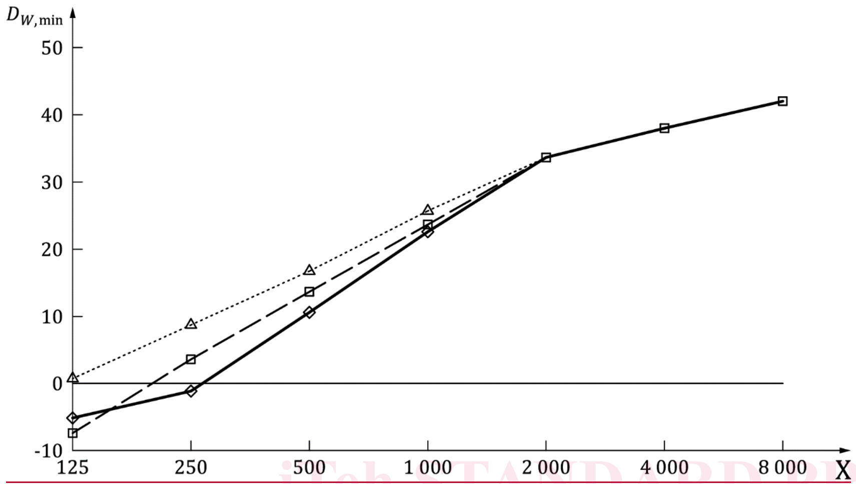

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X	octave band centre frequency in Hz	~~15665_ed2fig3_key1.EPS~~	Class C1
~~$D_{W,\text{min}}$~~ $D_{W,\text{min}}$	minimum insertion loss in dB	~~15665_ed2fig3_key2.EPS~~	Class C2
		~~15665_ed2fig3_key3.EPS~~	Class C3

Figure 3 — Minimum insertion loss required for Class C

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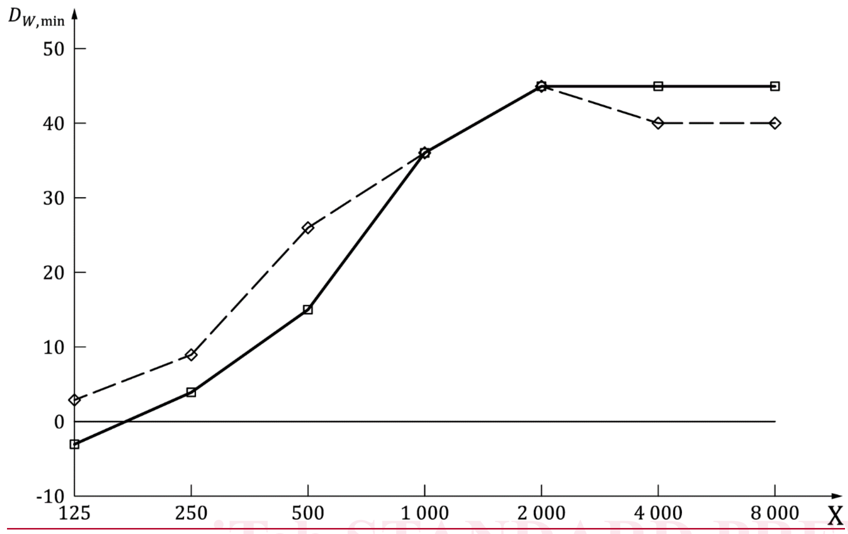

Key

X octave band centre frequency in Hz

~~15665_ed2fig4_key1.EPS~~ Class D2

~~$D_{W,\text{min}}$~~ $D_{W,\text{min}}$ minimum insertion loss in dB

~~15665_ed2fig4_key2.EPS~~ Class D3

Figure 4 — Minimum insertion loss required for Class D

NOTE 1 The reduction in overall A-weighted sound pressure level will depend on the frequency spectrum of the source. Some typical examples are given in 5.5 and 5.6.

NOTE 2 The values of the minimum required insertion loss given in Table 1 were derived from laboratory measurement results of about 60 different (standard) acoustic pipe insulation systems and obtained by statistical evaluation of the test data for each insulation class. For each octave band and each insulation class, the minimum required insertion loss was calculated as the arithmetic mean value of the respective test data minus their standard deviation (standard deviations were typically 3 dB in the octave bands 125 Hz to 1 000 Hz, and 9 dB from 2 000 Hz to 8 000 Hz). Slight simplifications led to the straight-line approximations displayed in Figures 1 to 4.

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