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Acoustics — Guidelines for noise control in offices and workrooms by means of acoustical screens

Acoustique — Lignes directrices pour la réduction du bruit dans les bureaux et locaux de travail au moyen d'écrans acoustiques

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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 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17624 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

Introduction

Besides silencers and enclosures (see ISO 14163 and ISO 15667, respectively), indoor screens are used as secondary means of noise control in workrooms and offices. For workplaces containing machinery, some information on such elements is given in ISO 11690-2:1996, Annexes E and F. More detailed information can be found in the bibliographic references.

Acoustics — Guidelines for noise control in offices and workrooms by means of acoustical screens

1 Scope

This International Standard deals with the effectiveness of acoustical screens. It specifies the acoustical and operational requirements to be agreed upon between the supplier or manufacturer and the user of acoustical screens. This International Standard is applicable to the following types of acoustical screens:

a) free-standing acoustical screens for offices, service areas, exhibition areas, and similar rooms;

b) acoustical screens integrated in the furniture of such rooms;

c) portable and removable acoustical screens for workshops;

d) fixed room partitions with more than 10 % of the connecting area open and acoustically untreated.

Walls of partial acoustic enclosures and cabins which, together with the room boundary surfaces, also partition a room and provide more than 10 % open and acoustically untreated area, are also treated as acoustical screens.

NOTE Guidance on complete acoustic enclosures is given in ISO 15667.

This International Standard is not applicable to cabinet walls and similar multi-layer walls whose thickness exceeds 0,2 m, nor to banners and other types of suspended baffles.

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.

ISO 140-3, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 3: Laboratory measurements of airborne sound insulation of building elements*

ISO 354, *Acoustics — Measurement of sound absorption in a reverberation room*

ISO 717-1, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation*

ISO 9053, *Acoustics — Materials for acoustical applications — Determination of airflow resistance*

ISO 10534-1, *Acoustics — Determination of sound absorption coefficient and impedance in impedance tubes — Part 1: Method using standing wave ratio*

ISO 10534-2, *Acoustics — Determination of sound absorption coefficient and impedance in impedance tubes — Part 2: Transfer-function method*

ISO 11654, *Acoustics — Sound absorbers for use in buildings — Rating of sound absorption*

ISO 11821:1997, *Acoustics — Measurement of the in situ sound attenuation of a removable screen*

3 Terms and definitions

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

3.1
(acoustical) screen
object that is specifically designed to shield one or several specified positions in a given area from the noise of (a) specified sound source(s)

[ISO 11821:1997]

3.2
portable or removable (acoustical) screen
(acoustical) screen that is designed to be dismantled or relocated without the other environmental conditions being changed

NOTE Adapted from ISO 11821:1997.

3.3
insertion sound pressure level difference
***in-situ* sound attenuation**
D_p
difference, in decibels, between the sound pressure levels, in octave bands or one-third-octave bands, at a specified position without and with the screen installed when one or several specified sound sources are in operation

NOTE Adapted from ISO 14163:1998.

3.4
A-weighted insertion sound pressure level difference
A-weighted (*in-situ*) sound attenuation
D_{pA}

difference, in decibels, between the A-weighted sound pressure levels at a specified position without and with the screen installed, when one or several specified sound sources are in operation

NOTE 1 The A-weighting is specified in IEC 61672-1.

NOTE 2 Adapted from ISO 14163:1998.

3.5
insertion loss
D_i
difference, in decibels, between the levels of the sound power, in octave bands or one-third-octave bands, radiated into the room by the sound source(s) to be shielded without and with the screen installed

NOTE By definition, the sound power is to be measured on an enveloping surface enclosing the sound source(s) to be shielded and the space for positioning the screen. It mainly applies to screens placed close to the source.

3.6
sound reduction index
transmission loss
R
quantity, in decibels, characterizing the sound energy transmitted through a building element in relation to the sound energy incident upon the element as per ISO 140-3

3.7
free-field screen sound attenuation
D_z
difference, in decibels, between the sound pressure level of the sound reaching a specified position on the direct path from the sound source to be shielded when the screen is not installed, and the level of the diffracted sound when the screen is installed, calculated from

$$D_z = 10 \lg \left(3 + 40 \frac{z}{\lambda}\right) \text{ dB} \quad (1)$$

where

z is the path length difference, in metres, between the longer sound propagation path around the least effective diffracting edge of the screen and the direct path;

λ is the wavelength, in metres, of the sound with the frequency f in hertz.

NOTE 1 The screen sound attenuation is given for octave-band or one-third-octave-band centre frequencies.

NOTE 2 The reduced screen sound attenuation, $D_{z,r}$ approximately accounts for reflections from a wall close to the sound source and considers the least effective diffracting edge of the screen, for a receiver located within the reverberation radius from the source, as per

$$D_{z,r} = 10 \lg \left(1 + 20 \frac{z}{\lambda}\right) \text{ dB} \quad (2)$$

It is 3 dB to 5 dB lower than the free-field screen sound attenuation D_z.

4 Symbols

The following symbols are used in this International Standard.

A equivalent absorption area, in square metres, see 5.3;

α absorption coefficient, see 8.1;

B average room width in the vicinity of the screen, in metres;

h screen height, in metres;

H average room height in the vicinity of the screen, in metres;

l_S length, in metres, of mean free path between reflections from scattering objects, typically 10 m;

r_r reverberation radius, in metres, see 5.3;

s distance from source to receiver, in metres, see 6.1;

T reverberation time, in seconds, see 5.3;

V volume, in cubic metres, see 5.3.

5 Basic principles and conditions of application

5.1 Contributions to the sound attenuation

Acoustical screens typically provide an A-weighted sound attenuation of up to 10 dB in offices and workrooms. This attenuation results from (see Figure 1):

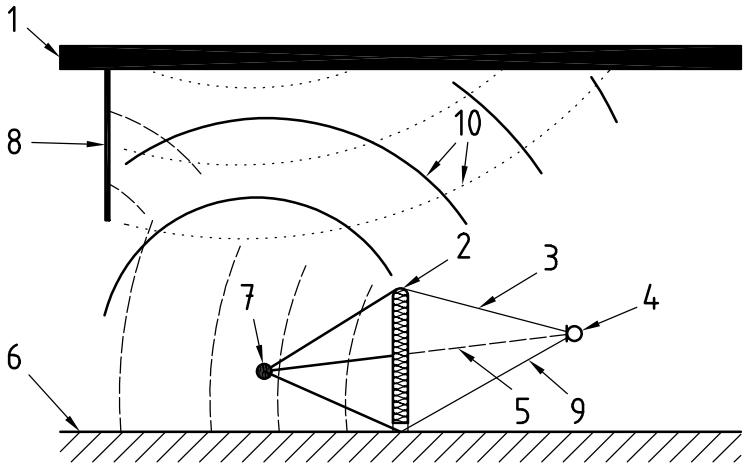
— sound absorption by the screen surface;

— blocking of the direct sound propagation path from a source to the receiver;

— partial decoupling of the sound fields on both sides of the screen.

The sound reduction index of all components forming the screen is usually sufficiently large due to structural requirements and, therefore, does not need any further consideration. Sealing joints between screen elements

is only necessary to optimize the performance of screens intended to provide an insertion loss of more than 10 dB.



Key

1	ceiling
2	acoustical screen
3	diffracted sound
4	receiver
5	direct sound
6	floor
7	sound source
8	obstacle
9	transmitted sound
10	reflected and scattered sound

Figure 1 — Sound propagation indoors with screen (schematic)

5.2 Absorption close to the sound source

The sound absorption of a screen close to a sound source results in a reduction in the sound power radiated by that source into the space behind the screen, which is characterized by the insertion loss D_i. The value of D_i is greater

— the higher the absorption coefficient of the screen surface facing the sound source,

— the more pronounced the directivity of the sound radiation towards the screen, and

— the more completely the sound source is enclosed by the screen.

5.3 Screening effect

Blocking the direct sound propagation path between the sound source and the receiver results in a reduction in direct sound characterized by the reduced screen attenuation $D_{z,r}$ as per Equation (2). The value of $D_{z,r}$ is greater

— the larger the smallest dimension of the screen,

— the shorter the distance between the sound source and screen, and

— the shorter the distance between the receiver and screen.

The shape and absorption properties of the screen are less important for the screening effect. The screening of direct sound has less of an effect on the *in-situ* sound attenuation at a receiver lying outside the reverberation radius around the sound source. At such a point, the sound reflected from all surfaces of the room and its fittings (for further details see ISO 11690-1:1996, 3.4.7) is stronger than the direct sound field. Usually, the reverberation radius will be a few metres only.

For a sound source with an omnidirectional sound radiation characteristic, the reverberation radius can be approximated as follows.

a) For approximately cubic rooms where Sabine's formula applies:

$$r_\mathrm{r} = \sqrt{\frac{A}{16\,\pi}} = 0{,}057\sqrt{\frac{V/\mathrm{m}^3}{T/\mathrm{s}}}\ \mathrm{m} \tag{3}$$

See ISO 11690-1:1996, 3.4.3 for A, and ISO 11690-1:1996, 3.4.10 for T.

b) For rooms with many scattering objects:

$$r_\mathrm{r} = l_\mathrm{S}/3 \tag{4}$$

where $l_\mathrm{S} = 4V/S$ is the length, in metres (m), of mean free path between reflections from scattering objects within volume V (in cubic metres, m^3), and S (in square metres, m^2) is the enveloping-surface area of all objects within the volume V. For industrial workrooms and open concept offices, l_S is typically 10m.

c) For rooms with a low ceiling (i.e. H is less than one-third of the other room dimensions), with only few scattering objects and little absorption at the ceiling:

$$r_\mathrm{r} = 3H/2 \tag{5}$$

d) For long rooms (i.e. B and H are less than one-third of the room length) where reflections mainly occur at the sides:

$$r_\mathrm{r} = 3B/2 \tag{6}$$

5.4 Decoupling

Screens dividing a room into several areas are called partitions. These result in a partial decoupling of the sound field on the source side of the screen from the sound field in the rest of the room. The decoupling is the more effective and the resulting sound pressure level difference is greater

— the smaller the open area beside the screen, and

— the greater the sound absorption at the perimeter of the opening.

This International Standard deals with thin screens only. Sound absorption on the top edge of the screen is not considered. It is therefore the sound absorption of the room boundary and the screen surfaces that is relevant. A sufficiently large, highly absorbent surface area should be provided near the edge of the screen.

5.5 Absorption away from the sound source

By virtue of their sound absorption, both sides of the screen contribute to an attenuation of the reverberant field (or diffuse field; see ISO 11690-1:1996, 3.4.8 for more details). This effect will become less in rooms with high absorption. In reverberant workrooms, with low absorption, the installation of absorbent screens can result in a considerable reduction of the spatially averaged sound pressure level.

5.6 Further effects of screens

5.6.1 In addition to noise control, there are other desired effects of screens, such as

a) protection against fragments coming off the workpiece, e.g. during blasting and grinding,

b) protection of the eyes, e.g. during arc welding,

c) protection against splashes of liquids, such as chemically aggressive or hot liquids, and hot molten material,