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Acoustics — Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms —

Part 1:
Frame document

Acoustique — Mesurage en laboratoire et sur site des transmissions latérales du bruit aérien, des bruits de choc et du bruit d'équipement technique de bâtiment entre des pièces adjacentes —

Partie 1: Document cadre

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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.

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 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).

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. 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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This second edition cancels and replaces the first edition (ISO 10848-1:2006), which has been technically revised with the following changes:

a) extension to field measurements;

b) extension to building service equipment;

c) normalized direction-averaged vibration level difference for junctions between lightweight elements has been introduced;

d) an assessment method for the decrease in vibration level with distance has been introduced;

e) transmission function measurements with a calibrated structure-borne sound source has been introduced;

f) definitions of element types A and B to avoid issues with the terms “heavy” and “light” have been added.

A list of all the parts in the ISO 10848 series can be found on the ISO website.

Acoustics — Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms —

Part 1:
Frame document

1 Scope

ISO 10848 (all parts) specifies measurement methods to characterize the flanking transmission of one or several building components. These measurements are performed in a laboratory test facility or in the field.

The performance of the building components is expressed either as an overall quantity for the combination of elements and junction (such as the normalized flanking level difference and/or normalized flanking impact sound pressure level) or as the vibration reduction index of a junction or the normalized direction-average vibration level difference of a junction.

Two approaches are used for structure-borne sound sources in buildings, a normalized flanking equipment sound pressure level and a transmission function that can be used to estimate sound pressure levels in a receiving room due to structure-borne excitation by service equipment in a source room. The former approach assumes that flanking transmission is limited to one junction (or no junction if the element supporting the equipment is the separating element), and the latter considers the combination of direct (if any) and all flanking transmission paths.

This document contains definitions, general requirements for test elements and test rooms, and measurement methods. Guidelines are given for the selection of the quantity to be measured, depending on the junction and the types of building elements involved. Other parts of ISO 10848 specify the application for different types of junction and building elements.

The quantities characterizing the flanking transmission can be used to compare different products, or to express a requirement, or as input data for prediction methods, such as ISO 12354-1 and ISO 12354-2.

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.

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

ISO 717-2, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 2: Impact sound insulation*

ISO 3382-2, *Acoustics — Measurement of room acoustic parameters — Part 2: Reverberation time in ordinary rooms*

ISO 7626-1, *Mechanical vibration and shock — Experimental determination of mechanical mobility — Part 1: Basic terms and definitions, and transducer specifications*

ISO 7626-5, *Vibration and shock — Experimental determination of mechanical mobility — Part 5: Measurements using impact excitation with an exciter which is not attached to the structure*

ISO 10140-4:2010, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 4: Measurement procedures and requirements*

ISO 10140-5:2010, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment*

IEC 61183, *Electroacoustics—Random-incidence and diffuse-field calibration of sound level meters*

IEC 61260 (all parts), *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1, *Electroacoustics — Sound level meters elements — Part 1: Specifications*

3 Terms and definitions

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

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

— IEC Electropedia: available at http://www.electropedia.org/

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

3.1
average sound pressure level in a room
L
ten times the common logarithm of the ratio of the space and time average of the sound pressure squared to the square of the reference sound pressure, the space average being taken over the entire room with the exception of those parts where the direct radiation of a sound source or the near field of the boundaries (walls, etc.) is of significant influence

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: If a continuously moving microphone is used, *L* is determined as follows:

$$L=10\lg\left(\frac{\frac{1}{T_\mathrm{m}}\int_0^{T_\mathrm{m}}p^2(t)\,\mathrm{d}t}{p_0^2}\right)$$

3.2
normalized flanking level difference
$D_{\mathrm{n,f}}$
difference in the space and time averaged sound pressure level produced in two rooms by one or more sound sources in one of them, when the transmission only occurs through a specified flanking path and the result is normalized to an equivalent sound absorption area in the receiving room as follows:

$$D_{\mathrm{n,f}}=L_1-L_2-10\lg\frac{A}{A_0}$$

where

L_1 is the average sound pressure level in the source room, in dB;

L_2 is the average sound pressure level in the receiving room, in dB;

A is the equivalent sound absorption area in the receiving room, in m^2;

A_0 is the reference equivalent sound absorption area, in m^2; A_0 = 10 m^2

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: For clarity, the term $D_{\mathrm{n,f}}$ is used when only one flanking path determines the sound transmission (such as with suspended ceilings) and the term $D_{\mathrm{n,f},ij}$ is used when only one specified transmission path *ij* out of several paths is considered (such as with structure-borne sound transmission on junctions of three or four connected elements).

3.3
normalized flanking impact sound pressure level

$L_{\mathrm{n,f}}$

space and time averaged sound pressure level in the receiving room produced by a tapping machine operating at different positions on a tested element (floor) in the source room, when the transmission only occurs through a specified flanking path and the result is normalized to an equivalent sound absorption area, in the receiving room and is expressed as follows:

$$L_{\mathrm{n,f}} = L_2 + 10\lg\frac{A}{A_0}$$

where

L_2 is the average sound pressure level in the receiving room, in dB;

A is the equivalent sound absorption area in the receiving room, in m^2;

A_0 is the reference equivalent sound absorption area, in m^2; A_0 = 10 m^2

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: For clarity, the term $L_{\mathrm{n,f}}$ is used when only one flanking path determines the sound transmission (such as with access floors) and the term $L_{\mathrm{n,f},ij}$ is used when only one specified transmission path *ij* out of several paths is considered (such as with structure-borne sound transmission on junctions of three or four connected elements).

3.4
normalized flanking equipment sound pressure level

$L_{\mathrm{ne0,f}}$

space and time averaged sound pressure level in the receiving room produced by a structure-borne sound source injecting a unit power (1 W) at different positions on a tested element in the source room, when the transmission only occurs through a specified flanking path and the result is normalized to an equivalent sound absorption area in the receiving room and is expressed as follows:

$$L_{\mathrm{ne0,f}} = L_{2\mathrm{e}} + 10\lg\frac{A}{A_0}$$

where

$L_{2\mathrm{e}}$ is the average sound pressure level in the receiving room with a structure-borne sound source injecting 1 W into the tested element, in dB;

A is the equivalent sound absorption area in the receiving room, in m^2;

A_0 is the reference equivalent sound absorption area, in m^2; A_0 = 10 m^2

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: For clarity, the term $L_{\mathrm{ne0,f}}$ is used when only one flanking path determines the sound transmission (such as with equipment installed on access floors or light façades) and the term $L_{\mathrm{ne0,f},ij}$ is used when only one specified transmission path *ij* out of several paths is considered (such as with structure-borne sound transmission on junctions of three or four connected elements).

Note 3 to entry: The sound pressure level generated by any equipment, $L_{\mathrm{ne,f,equip}}$, can be approximated when the equipment has been characterized using EN 15657 and its averaged installed power $L_{\mathrm{W,equip}}$ has been determined from the spatial average single equivalent mobility of the supporting element as described in EN 15657:2009, C.3 and using EN 15657 to give the installed power from the equipment and receiver characteristics.

3.5
transmission function for excitation position *k*

$D_{\mathrm{TF},k}$

difference between the space and time averaged sound pressure level in the receiving room and the structure-borne sound power level for a source at excitation position *k* on the source element as follows:

$$D_{\mathrm{TF},k} = L_{\mathrm{av},k} - L_{\mathrm{W},k}$$

where

$L_{\mathrm{av},k}$ is the average sound pressure level in the receiving room, in dB, referenced to 2×10^{-5} Pa;

$L_{\mathrm{W},k}$ is the structure-borne sound power level, in dB, referenced to 10^{-12} W.

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: The transmission function[25] is specific to the building in which it is measured and quantifies the combination of all the transmission paths from the power injected at a source position on an element to a spatial average sound pressure level in a receiving room in a building. In some cases, the transmission function will only correspond to the combination of all the flanking paths, but in some situations, it will be a combination of the direct transmission path and all the flanking paths. The building could either be a laboratory set-up (such as a flanking laboratory with wall and/or floor junctions) or an actual building.

3.6
spatial average transmission function

$D_{\mathrm{TF,av}}$

average transmission function from *K* excitation positions on the source element as follows:

$$D_{\mathrm{TF,av}} = 10\lg\left(\frac{\sum_{k=1}^{K} 10^{D_{\mathrm{TF},k}/10}}{K}\right)$$

3.7
normalized spatial average transmission function

$D_{\mathrm{TF,av,n}}$

spatial average transmission function (3.6) which is normalized to an equivalent sound absorption area in the receiving room that is calculated as follows:

$$D_{\mathrm{TF,av,n}} = D_{\mathrm{TF,av}} + 10\lg\frac{A}{A_0}$$

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: Normalized transmission functions can be used in the following ways:

a) to assess the accuracy of prediction models such as ISO 12354-1 or ISO 12354-2 which consider a limited number of flanking transmission paths that are either measured according to ISO 10848 (all parts), or estimated according to ISO 12354-1 or ISO 12354-2;

b) to create databases of average transmission functions as a simplified prediction tool for different building types;

c) to determine the optimum position for service equipment in an existing building.

3.8
structural reverberation time

T_{s}

time that would be required for the velocity or acceleration level in a structure to decrease by 60 dB after the structure-borne sound source has stopped

Note 1 to entry: This quantity is expressed in seconds.

Note 2 to entry: The definition of T_s with a decrease by 60 dB of the velocity or acceleration level in a structure can be fulfilled by linear extrapolation of shorter evaluation ranges.

3.9
average velocity level

L_v

ten times the common logarithm of the ratio of the time and space averaged mean-square normal velocity of an element to the squared reference velocity as follows:

$$L_\mathrm{v} = 10\lg\left(\frac{\frac{1}{T_\mathrm{m}}\int_0^{T_\mathrm{m}} v^2(t)\mathrm{d}t}{v_0^2}\right)$$

where v_0 is the reference velocity, in m/s; $v_0 = 1 \times 10^{-9}$ m/s

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: The reference velocity preferred in ISO 1683 is 1×10^{-9} m/s, although a common reference value in some countries is still $v_0 = 5 \times 10^{-8}$ m/s.

Note 3 to entry: Instead of the average velocity level, the average acceleration level L_a can be measured. The reference acceleration preferred in ISO 1683 is 1×10^{-6} m/s².

3.10
velocity level difference

$D_{\mathrm{v},ij}$

difference between the *average velocity level* (3.9) of an element *i* and that of an element *j*, when only the element *i* is excited (airborne or structure-borne)

Note 1 to entry: This quantity is expressed in decibels.

3.11
direction-averaged velocity level difference

$\overline{D_{\mathrm{v},ij}}$

arithmetic average of $D_{\mathrm{v},ij}$ and $D_{\mathrm{v},ji}$ as defined as follows:

$$\overline{D_{\mathrm{v},ij}} = \frac{1}{2}\left(D_{\mathrm{v},ij} + D_{\mathrm{v},ji}\right)$$

where

$D_{\mathrm{v},ij}$ is the difference between the *average velocity level* (3.9) of an element *i* and that of an element *j*, when only the element *i* is excited, in dB;

$D_{\mathrm{v},ji}$ is the difference between the average velocity level of an element *j* and that of an element *i*, when only the element *j* is excited, in dB.

Note 1 to entry: This quantity is expressed in decibels.

3.12
equivalent absorption length of an element

a_j

length of a fictional totally-absorbing junction of an element *j* when the critical frequency is assumed to be 1 000 Hz, giving the same losses as the total losses of the element *j* in a given situation as follows:

$$a_j = \frac{2{,}2\pi^2 S_j}{T_{\mathrm{s},j} c_0 \sqrt{\dfrac{f}{f_{\mathrm{ref}}}}}$$

where

$T_{\mathrm{s},j}$ is the *structural reverberation time* (3.8) of the element *j*, in s;

S_j is the surface area of the element *j*, in m^2;

c_0 is the speed of sound in air, in m/s;

f is the frequency, in Hz;

f_{ref} is the reference frequency, in Hz ($f_{\mathrm{ref}} = 1\,000$ Hz).

Note 1 to entry: This quantity is expressed in metres.

3.13

vibration reduction index

K_{ij}

direction-averaged velocity level difference (3.11) between two elements across a junction that is normalised to the junction length and the equivalent sound absorption length of both elements as follows:

$$K_{ij} = \overline{D_{\mathrm{v},ij}} + 10\lg\left(\frac{l_{ij}}{\sqrt{a_i\, a_j}}\right)$$

where

$\overline{D_{\mathrm{v},ij}}$ is the direction-averaged velocity level difference between elements *i* and *j*, in dB;

l_{ij} is the junction length between elements *i* and *j*, in m;

a_i, a_j are the equivalent absorption lengths of elements *i* and *j*, in m.

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: K_{ij} can be obtained from measurements of the *velocity level difference* (3.10) in both directions across the junction and the *structural reverberation time* (3.8) of the two elements *i* and *j*.

3.14

normalized direction-average vibration level difference

$\overline{D_{\mathrm{v},ij,\mathrm{n}}}$

difference in velocity level between elements *i* and *j*, averaged over the excitation from *i* and excitation from *j*, and normalized to the junction length and the measurement areas on both elements as follows:

$$\overline{D_{\mathrm{v},ij,\mathrm{n}}} = \overline{D_{\mathrm{v},ij}} + 10\lg\left(\frac{l_{ij}\, l_0}{\sqrt{S_{\mathrm{m},i}\, S_{\mathrm{m},j}}}\right)$$

where

l_0 is the reference length, in m; $l_0 = 1$ m;

$S_{\mathrm{m},i}$ is the area of element *i* over which the velocity is measured, in m^2;

$S_{\mathrm{m},j}$ is the area of element *j* over which the velocity is measured, in m^2.

Note 1 to entry: This quantity is expressed in decibels.

3.15
Type A element

element with a *structural reverberation time* (3.8) that is primarily determined by the connected elements (up to at least the 1 000 Hz one-third octave band) and a decrease in vibration level of less than 6dB across the element in the direction perpendicular to the junction line (up to at least the 1 000 Hz one-third octave band)

Note 1 to entry: Examples include cast *in situ* concrete, solid wood (including cross laminated timber panels), glass, plastic, metal, bricks/blocks/slabs with a finish/topping (e.g. plaster, parge coat, screed, concrete) that mechanically connects them together.

Note 2 to entry: An element may only be defined as Type A over part or parts of the frequency range. For example, some masonry walls can be Type A elements in the low-frequency and mid-frequency ranges and a *Type B element* (3.16) in the high-frequency range[15].

3.16
Type B element

element that is not a *Type A element* (3.15)

Note 1 to entry: Examples typically include plasterboard/timber cladding on timber or metal frames.

Note 2 to entry: An element may only be defined as Type B over part or parts of the frequency range. For example, some masonry walls can be Type A elements in the low-frequency and mid-frequency ranges and a Type B element in the high-frequency range[15].

4 Quantities to characterize flanking transmission

4.1 General

Flanking transmission by coupled elements and junctions is characterized in the following ways:

- by vibration transmission across a junction using K_{ij} for Type A elements or combinations of Type A and B elements;
- by vibration transmission across a junction using $\overline{D_{\mathrm{v},ij,\mathrm{n}}}$ for Type B elements;
- by an overall transmission quantity for a specified flanking path ($D_{\mathrm{n,f}}$, $L_{\mathrm{n,f}}$ or $L_{\mathrm{ne0,f}}$) for Type B elements.

Each of these quantities has its own restrictions and field of application.

The vibration reduction index is related to the normalized flanking level difference using Formula (1):

$$K_{ij} = D_{\mathrm{n,f}} - \frac{R_i + R_j}{2} - 10\lg\left(\frac{\sqrt{a_i a_j}}{l_{ij}}\right) + 10\lg\left(\frac{\sqrt{S_i S_j}}{A_0}\right) \qquad (1)$$

where R_i and R_j only correspond to resonant transmission for elements *i* and *j*, hence R_i and R_j measured according to ISO 10140-2 or ISO 15186-1 shall be corrected before they can be inserted in Formula (1) because they include forced transmission. ISO 12354-1 indicates how to correct the measured sound reduction index to remove the forced transmission.