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Acoustics — Measurement of sound insulation in buildings and of building elements —

Part 3:

Laboratory measurements of airborne sound
insulation of building elements

*Acoustique — Mesurage de l'isolement acoustique des immeubles et des
éléments de construction —*

*Partie 3: Mesurage en laboratoire de l'affaiblissement des bruits aériens
par les éléments de construction*



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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.

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 140-3 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This second edition cancels and replaces the first edition (ISO 140-3:1978) and its amendment ISO 140-3:1978/Amd.1:1990.

ISO 140 consists of the following parts, under the general title *Acoustics — Measurement of sound insulation in buildings and of building elements*:

- *Part 1: Requirements for laboratory test facilities with suppressed flanking transmission*
- *Part 2: Determination, verification and application of precision data*
- *Part 3: Laboratory measurements of airborne sound insulation of building elements*
- *Part 4: Field measurements of airborne sound insulation between rooms*
- *Part 5: Field measurements of airborne sound insulation of facade elements and facades*
- *Part 6: Laboratory measurements of impact sound insulation of floors*

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- *Part 7: Field measurements of impact sound insulation of floors*
- *Part 8: Laboratory measurement of the reduction of transmitted impact noise by floor coverings on a solid standard floor*
- *Part 9: Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it*
- *Part 10: Laboratory measurement of airborne sound insulation of small building elements*
- *Part 12: Laboratory measurement of room-to-room airborne and impact sound insulation of an access floor*

Annexes A, B and C form an integral part of this part of ISO 140. Annexes D, E, F and G are for information only.

Acoustics — Measurement of sound insulation in buildings and of building elements —

Part 3:

Laboratory measurements of airborne sound insulation of building elements

1 Scope

This part of ISO 140 specifies a laboratory method of measuring the airborne sound insulation of building elements such as walls, floors, doors, windows, façade elements and façades, except those classified as small building elements (for which a measuring method is specified in ISO 140-10¹⁾).

The results obtained can be used to design building elements with appropriate acoustic properties, to compare the sound insulation properties of building elements and to classify such elements according to their sound insulation capabilities.

The measurements are performed in laboratory test facilities in which transmission of sound on flanking paths is suppressed. Results of measurements made in accordance with this part of ISO 140 therefore shall not be applied directly in the field without accounting for other factors affecting sound insulation, especially flanking transmission and loss factor.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 140. At the time of publication, the editions indicated were valid. All standards are subject

to revision, and parties to agreements based on this part of ISO 140 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 140-1:—²⁾, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 1: Requirements for laboratory test facilities with suppressed flanking transmission.*

ISO 140-2:1991, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 2: Determination, verification and application of precision data.*

ISO 354:1985, *Acoustics — Measurement of sound absorption in a reverberation room.*

ISO 717-1:—³⁾, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation.*

IEC 225:1966, *Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations.*

IEC 651:1979, *Sound level meters.*

1) ISO 140-10:1991, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 10: Laboratory measurement of airborne sound insulation of small building elements.*

2) To be published. (Revision of ISO 140-1:1990)

3) To be published. (Revision of ISO 717-1:1982)

IEC 804:1985, *Integrating-averaging sound level meters*.

IEC 942:1988, *Sound calibrators*.

3 Definitions

For the purposes of this part of ISO 140, the following definitions apply.

3.1 average sound pressure level in a room: Ten times the common logarithm of the ratio of the space and time average of the squared sound pressure 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.

This quantity is denoted by L and is expressed in decibels.

If a continuously moving microphone is used, L is determined by

$$L = 10 \lg \frac{\frac{1}{T_m} \int_0^{T_m} p^2(t) dt}{p_0^2} \text{ dB} \quad \dots (1)$$

where

- p is the sound pressure, in pascals;
- p_0 is the reference sound pressure and is equal to 20 μPa ;
- T_m is the integration time, in seconds.

If fixed microphone positions are used, L is determined by

$$L = 10 \lg \frac{p_1^2 + p_2^2 + \dots + p_n^2}{np_0^2} \text{ dB} \quad \dots (2)$$

where $p_1, p_2, \dots, p_n$ are r.m.s. sound pressures at n different positions in the room. In practice, usually the sound pressure levels L_i are measured. In this case L is determined by

$$L = 10 \lg \frac{1}{n} \sum_{i=1}^n 10^{L_i/10} \text{ dB} \quad \dots (3)$$

where L_i are the sound pressure levels L_1 to L_n at n different positions in the room.

3.2 sound reduction index: Ten times the common logarithm of the ratio of the sound power W_1 which is incident on a partition under test to the sound power W_2 transmitted through the specimen.

This quantity is denoted by R and is expressed in decibels.

$$R = 10 \lg \frac{W_1}{W_2} \text{ dB} \quad \dots (4)$$

In this part of ISO 140 the sound reduction index is evaluated from

$$R = L_1 - L_2 + 10 \lg \frac{S}{A} \text{ dB} \quad \dots (5)$$

where

- L_1 is the average sound pressure level in the source room, in decibels;
- L_2 is the average sound pressure level in the receiving room, in decibels;
- S is the area of the test specimen, in square metres, which is equal to the free test opening;
- A is the equivalent sound absorption area in the receiving room, in square metres.

NOTES

1 The derivation of equation (5) from equation (4) assumes that the sound fields are perfectly diffuse and that the sound radiated into the receiving room is transmitted only through the specimen.

2 The expression "sound transmission loss" (TL) is also in use in English-speaking countries. It is equivalent to "sound reduction index".

3.3 apparent sound reduction index: Ten times the common logarithm of the ratio of the sound power W_1 which is incident on a partition under test to the total sound power transmitted into the receiving room if, in addition to the sound power W_2 transmitted through the specimen, the sound power W_3 , transmitted by flanking elements or by other components, is significant.

This quantity is denoted by R' and is expressed in decibels.

$$R' = 10 \lg \left(\frac{W_1}{W_2 + W_3} \right) \text{ dB} \quad \dots (6)$$

In general, the sound power transmitted into the receiving room consists of the sum of several components. Also in this case, under the assumption that there are sufficiently diffuse sound fields in the two rooms, the apparent sound reduction index in this part of ISO 140 is evaluated from

$$R' = L_1 - L_2 + 10 \lg \frac{S}{A} \quad \text{dB} \quad \dots (7)$$

Thus, in the apparent sound reduction index, the sound power transmitted into the receiving room is related to the sound power which is incident on the test specimen as in equation (5), irrespective of the actual conditions of transmission.

4 Equipment

The equipment shall comply with the requirements of clause 6.

The accuracy of the sound level measurement equipment shall comply with the requirements of accuracy classes 0 or 1 defined in IEC 651 and IEC 804. Diffuse field calibration of the measurement equipment is required unless microphones with the same diffuse field frequency response are used in both the source and the receiving room.

If absolute values of sound pressure levels have to be obtained, the complete measuring system including the microphone shall be adjusted before each measurement using a sound calibrator which complies with the requirements of accuracy class 1 defined in IEC 942.

The third-octave band filters shall comply with the requirements defined in IEC 225.

The reverberation time measurement equipment shall comply with the requirements defined in ISO 354.

Requirements for the sound source are given in 6.1 and annex C.

NOTE 3 For pattern evaluation (type testing) and regular verification tests, recommended procedures for sound level meters are given in OIML R58 and OIML R88⁴⁾.

4) OIML R58:1984, *Sound level meters*.

OIML R88:1989, *Integrating-averaging sound level meters*.

These documents may be obtained from: Organisation internationale de métrologie légale, 11, rue Turgot, 75009 Paris, France.

5 Test arrangement

5.1 Rooms

Laboratory test facilities shall comply with the requirements of ISO 140-1.

5.2 Test specimen

The sound transmission of a specimen can depend on the temperature and relative humidity in the test rooms at time of test and/or during curing or conditioning of the test specimen. The conditions shall be reported.

5.2.1 Partitions

The size of the test partitions is determined by the size of the test opening of the laboratory test facility, as it is defined in ISO 140-1. These sizes are approximately 10 m² for walls, and between 10 m² and 20 m² for floors, with the shorter edge length for both walls and floors being not less than 2,3 m.

A smaller size is permissible if the wavelength of free flexural waves at the lowest frequency considered is smaller than half the minimum dimension of the specimen. The smaller the specimen, however, the more sensitive the results will be to edge constraint conditions and to local variations in sound fields.

Preferably install the test partition in a manner as similar as possible to the actual construction with a careful simulation of normal connections and sealing conditions at the perimeter and at joints within the partition. The mounting conditions shall be stated in the test report.

The sound reduction index of solid walls and floors depends strongly on coupling to surrounding structures. In order to describe properly the effect of the mounting, it is recommended to measure and to report the loss factor in these cases (see annex E).

If the test specimen is installed in an aperture between the source room and the receiving room, the ratio of the aperture depths shall be approximately 2:1 unless this is inconsistent with the practical use of the test specimen.

If the specimen has one surface which is significantly more absorbent than the other, the surface with the

higher absorption shall face the source room. Install diffusing elements in the source room in such cases.

In laboratories complying with ISO 140-1, ensure that the sound transmitted by any indirect path is negligible compared with the sound transmitted through the test specimen. In order to verify this, the value of $R'_{\max}$ for the laboratory facility shall be measured. This is done with a highly insulating construction inserted in the test opening. The procedure to determine $R'_{\max}$ is given in annex A of ISO 140-1:—.

If the measured value of R' for a test specimen is less than or equal to $(R'_{\max} - 15 \text{ dB})$, the indirectly transmitted sound may be considered negligible and the result is called R .

If R' is larger than $(R'_{\max} - 15 \text{ dB})$, the contribution of the flanking transmission for this special case shall be investigated. The methods mentioned in annex D may be used. If necessary, try an improvement in flanking path suppression of the test facility.

Appropriate statements in the test report are necessary [see I) of clause 9] if finally R' is larger than $(R'_{\max} - 15 \text{ dB})$. No calculated corrections shall be applied with the exception of measurements on doors, windows, glazings and façade elements (see annex B).

If the test specimen is smaller than the test opening, a preliminary test shall be carried out to ensure that sound power transmitted through the surrounding partition is small compared with the sound power transmitted through the test specimen. This may be checked by the methods described in annex D.

5.2.2 Doors, windows, glazings and façade elements

5.2.2.1 General

The test specimen shall be tested in the same manner as a partition (see 5.2.1). If the test specimen is smaller than the test opening, a special partition of sufficiently high sound insulation shall be built into the test opening and the specimen shall be placed in that partition. The sound transmitted through this partition and any other indirect path should be negligible compared with the sound transmitted through the test specimen. If this is not the case, the test results shall be corrected (see annex B).

If the test specimen is intended to be readily openable, it shall be installed for test so that it can be opened and closed in the normal manner. It shall be opened and closed at least five times immediately before testing.

Doors shall be inserted so that the lower edge is situated as near as possible to the level of the floor of the test rooms to reproduce conditions in the actual building.

For glazings, windows, doors, etc., the area S is the area of the opening in the filler wall required to accommodate the test specimen.

The sound insulation of certain glazing systems or elements, especially those incorporating laminated glass, may be dependent on the room temperature during the measurements. It is recommended that the sound insulation measurements on such test specimens are made at $20 \text{ °C} \pm 3 \text{ °C}$ in both rooms. The test specimens should be stored for 24 h at the test temperature. In addition, it can be advantageous to make measurements at temperatures similar to those for which the test object is designed.

NOTES

4 As the sound insulation of windows, doors and small façade elements depends on the dimensions, the sound insulation in practice could differ considerably if a construction has an area other than the one tested in the laboratory.

It is unlikely that test specimens (especially window panes) whose areas have a ratio of up to 2:1 will show differences in sound insulation greater than 3 dB in the single-number quantity. With an area greater than that which has been tested, a lower sound insulation will generally result. Accurate, reliable values can be obtained only by measuring a test object of the size of interest.

5 Measurements on square specimens can yield smaller sound insulation than measurements on rectangular ones with the same area.

5.2.2.2 Installation of windows

The installation of a window assembly shall be as near as possible to the method which would be used in practice. When the window is mounted in the test opening, the niches on both sides of the windows shall have different depths, preferably in a ratio of about 2:1, unless this conflicts with the particular design of the window. However, it is to be expected that results obtained with niche depths of different ratios will differ.

The gap between the window and the test opening (about 10 mm to 13 mm around the window when mounted in the test opening) should be filled with absorbing material (for example, mineral wool) and made airtight using an elastic sealant on both sides or in accordance with the manufacturer's instructions.

5.2.2.3 Installation of glass panes

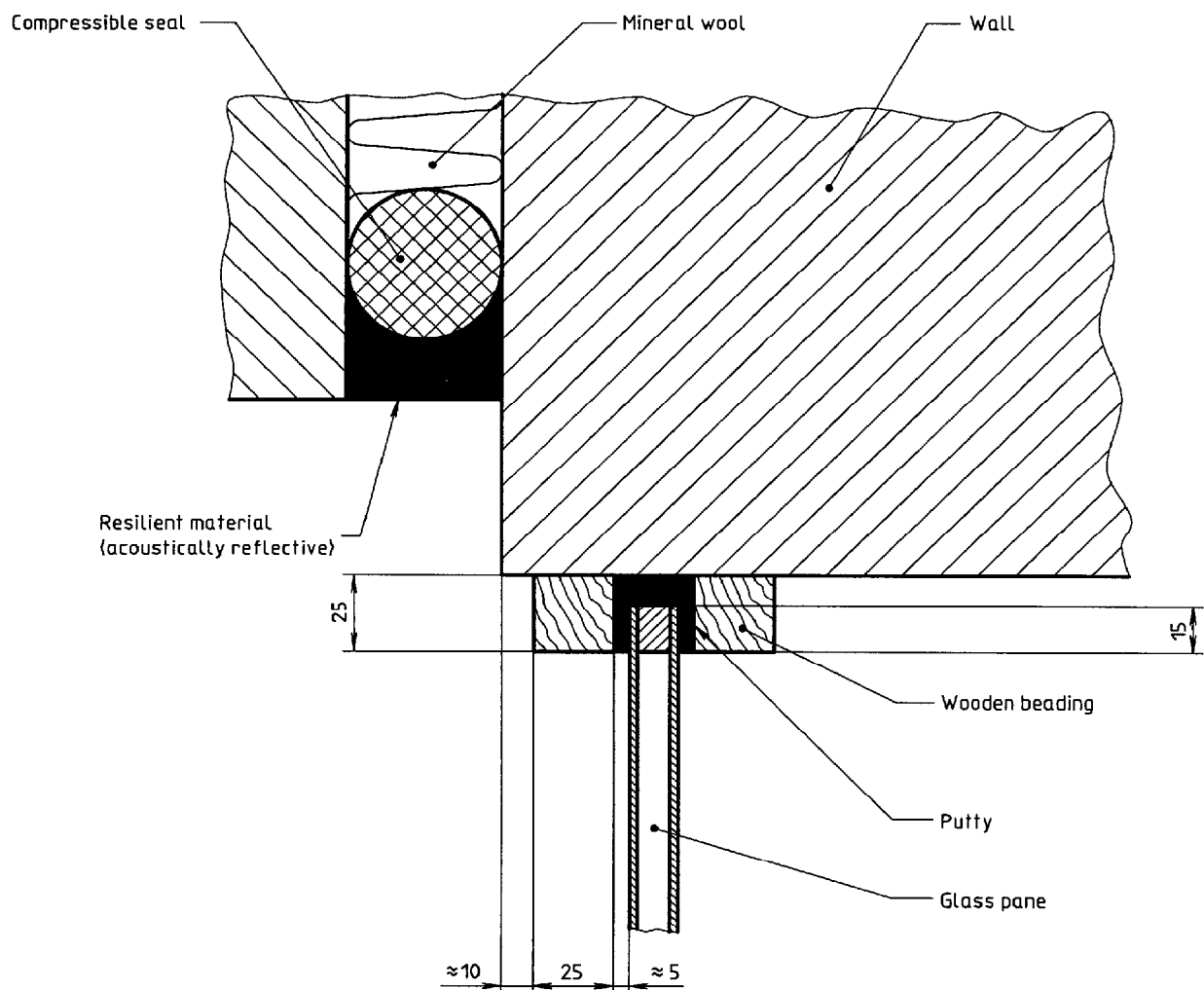
The glass pane shall be installed into the test opening so that the niches on both sides of the glass pane have different depths with a ratio of 2:1. A gap of about 10 mm shall remain between the glass and the reveal of the test opening. This gap shall be filled with putty as specified in annex A.

To fix the test specimen, two wooden beads (25 mm × 25 mm) shall be used (see figure 1). The

space between the pane and the locking ledge shall be filled with putty, as described in annex A, about 5 mm thick. The beads shall cover not more than 15 mm and not less than 12 mm of the glass⁵⁾.

NOTE 6 The sound insulation measured for a type of glazing does not necessarily represent the sound insulation of a window with that glazing. Preferably, therefore, the complete windows should be measured as well to obtain information on sound insulation of the windows and not only of the glazing.

Dimensions in millimetres



NOTE — This example shows a double-glazed pane installed directly into the (smaller) aperture of a double filler wall (see ISO 140-1:—, annex C for more details).

Figure 1 — Installation of a glass pane

5) This method of mounting and sealing a glass pane into the test opening is given as a practical, quick, airtight and reproducible solution, although this is not the type of mounting in practice.