BRITISH STANDARD

BS EN ISO
11957:2009

Acoustics — Determination of sound insulation performance of cabins — Laboratory and in situ measurements (ISO 11957:1996)

ICS 17.140.01

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN ISO 11957:2009. It is identical to ISO 11957:1996. It supersedes BS EN ISO 11957:1997 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EH/1/4, Machinery noise.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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This European Standard was approved by CEN on 3 August 2009.

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Foreword

The text of ISO 11957:1996 has been prepared by Technical Committee ISO/TC 43 “Acoustics” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 11957:2009 by 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of an identical text or by endorsement, at the latest by January 2010, and conflicting national standards shall be withdrawn at the latest by January 2010.

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This document supersedes EN ISO 11957:1996.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directives.

For relationship with EC Directives, see informative Annexes ZA and ZB, which are integral parts of this document.

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Endorsement notice

The text of ISO 11957:1996 has been approved by CEN as a EN ISO 11957:2009 without any modification.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 98/37/EC, amended by 98/79/EC on machinery.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING - Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Annex ZB
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC on machinery.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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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 lialison 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 11957 was prepared by Technical Committee ISO/TC 43, *Acoustics,* Subcommittee SC 1, *Noise,* on request from CEN/TC 211, *Acoustics.*

Related standards concern noise attenuation measurements of enclosures under laboratory conditions (ISO 11546-1) and *in situ* (ISO 11546-2).

Annexes A and B of this International Standard are for information only.

INTERNATIONAL STANDARD © ISO ISO 11957:1996(E)

Acoustics — Determination of sound insulation performance of cabins — Laboratory and *in situ* measurements

1 Scope

This International Standard specifies a laboratory method (clause 6) and *in situ* methods (clause 7) for the determination of the sound insulation performance of sound-protecting cabins. The sound insulation performance is the reduction in sound pressure level or sound power level afforded by the cabin. The methods are applicable to cabins with a small leak ratio ($\theta \leqslant 2\ \%$).

This International Standard is applicable to a complete cabin only and not to the individual components from which it is made.

NOTE 1 Sound insulations for cabin components such as wall elements, doors, windows, silencers, etc. should be measured according to other relevant standards.

Requirements for the test environment in the laboratory are based on those given in ISO 3741.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 717-1:—[1], *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation.*

ISO 3741: —[2], *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for reverberation rooms.*

ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment.*

IEC 651:1979, *Sound level meters.*

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

IEC 942:1988, *Sound calibrators.*

IEC 1260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters.*

3 Definitions

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

3.1 A-weighting: Frequency weighting in accordance with IEC 651.

3.2 cabin: An enclosure specially designed to shield human beings from environmental noise.

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

2) To be published. (Revision of ISO 3741:1988 and ISO 3742:1988)

3.3 sound pressure level, L_p: Ten times the logarithm to the base 10 of the ratio of the mean-square sound pressure to the square of the reference sound pressure (= 20 μPa). It is expressed in decibels.

3.4 average sound pressure level (on a mean-square basis), $\overline{L_p}$:

$$\overline{L_p} = 10 \lg \left(\frac{10^{0,1\,L_{p1}} + 10^{0,1\,L_{p2}} + \ldots + 10^{0,1\,L_{pn}}}{n} \right) \text{dB}$$

where

$L_{p1}, L_{p2}, \ldots, L_{pn}$ are the sound pressure levels, in decibels, to be averaged;

n is the number of values to be averaged.

It is expressed in decibels.

3.5 sound pressure insulation, D_p: Difference, in one-third-octave or octave bands, between the sound pressure level of an external reverberant sound field and the sound pressure level inside a cabin located in this field. It is expressed in decibels.

3.6 apparent sound pressure insulation, D'_p: Difference, in one-third-octave or octave bands, between the sound pressure level in a room and the sound pressure level in a cabin located in the room. It is expressed in decibels. The sound field in the room need not necessarily be diffuse.

NOTE 2 The word "apparent" indicates that the measurement has been carried out under *in situ* conditions.

3.7 apparent A-weighted sound pressure insulation, $D'_{p\mathrm{A}}$: Difference in A-weighted sound pressure levels measured in the room and in the cabin, respectively, when the actual environmental noise is used as the sound source. It is expressed in decibels. (See note 2.)

3.8 weighted sound pressure insulation, $D_{p,\mathrm{w}}$: Single-number value determined in accordance with the method stated in ISO 717-1. It is expressed in decibels. However, the sound reduction index used in ISO 717-1 is replaced by the sound pressure insulation, D_p. (See clause 8.)

3.9 apparent weighted sound pressure insulation, $D'_{p,\mathrm{w}}$: Single-number value determined in accordance with the method stated in ISO 717-1. It is expressed in decibels. However, the sound reduction index used in ISO 717-1 is replaced by the apparent sound pressure insulation, D'_p. (See note 2 and clause 8.)

3.10 estimated cabin noise insulation, $D_{p\mathrm{A,e}}$: Calculated reduction in A-weighted sound pressure level for a specific spectrum (the actual noise), obtained from D_p measured in accordance with this International Standard. It is expressed in decibels. (See annex A.)

3.11 apparent estimated cabin noise insulation, $D'_{p\mathrm{A,e}}$: Calculated reduction in A-weighted sound pressure level for a specific spectrum (the actual noise), obtained from D'_p measured in accordance with this International Standard. It is expressed in decibels. (See note 2 and annex A.)

3.12 internal noise level, $L_{p\mathrm{A}}$: A-weighted average sound pressure level inside the cabin caused by sound sources which are an integrated part of the cabin. It is expressed in decibels.

3.13 background noise level: Averaged sound pressure level inside or outside the cabin when the loudspeakers, the actual environmental noise and the sound sources which are an integrated part of the cabin are switched off. It is expressed in decibels.

3.14 leak ratio, θ: Ratio between the area of all openings of the cabin and the total interior surface area (including openings) of the cabin.

NOTES

3 The reciprocal value of the leak ratio is designated the seal ratio, ψ ($\psi = 1/\theta$).

4 Openings provided with sufficiently effective silencers are not regarded as openings in this context.

3.15 empty cabin: Normally equipped cabin with no human beings inside.

3.16 reverberant sound field: That portion of the sound field in the test room where the influence of sound received directly from the source is negligible.

3.17 room: Enclosed space, external to the cabin, where sound is generated.

4 Test environment and choice of suitable quantity

If the test is conducted in a laboratory (clause 6), the test environment shall be a reverberation room as specified in ISO 3741. If the test is conducted *in situ*

(clause 7), no specific requirements concerning the room need be fulfilled. An external sound field generated in the room is used to determine the cabin sound pressure insulation.

Differences can occur between laboratory and *in situ* test results. Therefore, only data based on the same measurement method shall be used when comparing the performance of different cabins.

NOTE 5 The size and volume of the cabin may influence the sound insulation performance. Consequently, it is recommended that only data for cabins of approximately equal sizes be used when comparing the performance of different cabins.

In cases where a single-number value is wanted as a general quantity describing the sound insulation, the weighted sound pressure insulation, $D_{p,\mathrm{w}}$, is the preferred quantity. The weighted sound pressure insulation is a practical single-number value to be used for a rough comparison of different cabins. However, this quantity shall not be taken as a general measure of the sound insulation performance of the cabin, as the performance in actual situations strongly depends on the spectrum of the actual noise.

It is possible to calculate approximately the reduction in the A-weighted sound pressure level due to the cabin, using a known spectrum of the environmental noise (the actual noise). (See annex A.)

5 Instrumentation

The instrumentation system, including microphone and cable, shall meet the requirements for a type 1 instrument as specified in IEC 651 or, in the case of integrating-averaging sound level meters, the requirements for a type 1 instrument as specified in IEC 804.

NOTE 6 Generally, an integrating-averaging sound level meter is preferred.

For measurements in octave or one-third-octave bands, the instrumentation system shall meet the requirements for a class 1 filter as specified in IEC 1260.

Before and after each series of measurements, the stability and calibration of the entire instrumentation shall be verified at one or more frequencies over the frequency range of interest using an acoustical calibrator of class 1 in accordance with IEC 942.

NOTES

7 An equivalent verification method which has been proved capable of checking the stability of the measurement system may be used.

8 For measurements carried out *in situ*, class 2 instruments are acceptable.

6 Measurement of sound insulation performance in the laboratory

6.1 General

The test environment shall be a reverberation room complying with the specifications given in ISO 3741.

A reverberant sound field is generated in the room and the sound pressure level difference between the room and the inside of an empty cabin is determined. (See 6.4 to 6.6.)

6.2 Cabin locations

The cabin shall be placed asymmetrically on the floor in such a way that no cabin wall is parallel to any wall of the room.

For measurements in the frequency range from 100 Hz to 10 000 Hz, the distance between the cabin and the walls and ceiling of the room shall be at least one-half wavelength corresponding to the centre frequency of the lowest frequency band of interest. Furthermore, the distance between the cabin and any diffusing elements in the room shall be at least one-half of this wavelength. For measurements in the frequency range from 50 Hz to 80 Hz, the distance shall be at least 2 m.

The cabin shall be present during all measurements in the room.

6.3 Cabin mounting and conditions

The cabin shall be installed as specified by the manufacturer.

The cabin shall be empty during the measurements. Unless otherwise specified in the operating instructions for the cabin, the doors and windows shall be closed, noise sources forming an integral part of the cabin such as ventilating fans shall be switched off, and valves or dampers in the ventilation system shall be open when measuring the sound insulation performance. For additional information, the sound insulation performance with the valves closed may be determined. The sound pressure level inside the cabin due to noise sources forming an integral part of the cabin, if any, shall be determined as specified in 6.7. All movable parts of the cabin shall be operated at least 10 times before the measurement is carried out.

For cabins without an integrated floor, there shall be no leaks between the cabin and the floor of the room.

NOTE 9 A high degree of flanking transmission in the floor of the room may influence the measurement result (sound transmission from the room to the cabin through the floor).

6.4 Measurement of the sound pressure level in the room

At least two loudspeaker positions shall be used to generate the sound field in the reverberation room. The measurements can be carried out either sequentially by moving one loudspeaker cabinet between the chosen positions, or several loudspeakers can be operated simultaneously provided that each loudspeaker has a separate noise generator and power amplifier.

The distance between the loudspeaker positions shall be at least 3 m. The distance between any loudspeaker position and the cabin shall be as great as possible and at least 2 m. The distance between the loudspeakers and any microphone positions shall be at least 2 m.

NOTE 10 The minimum distance of 2 m will be sufficient, provided that the loudspeaker is approximately omnidirectional and that loudspeaker positions close to room surfaces or corners are avoided.

The generated sound shall be steady and have a continuous spectrum in the frequency range considered. If the measurement is carried out using octave bands, the spectrum shall be approximately flat within each octave band. The three one-third-octave band levels within each octave band shall not differ by more than 6 dB in the octave band of 125 Hz, 5 dB in the band of 250 Hz, and 4 dB in the bands of higher frequencies. The output shall be sufficiently high to give a sound pressure level inside the cabin exceeding the background noise level by at least 6 dB, and preferably by more than 12 dB for all frequency bands of interest. Correction for the influence of background noise inside the cabin shall be carried out in accordance with ISO 3741.

The frequency range shall be at least 100 Hz to 5 000 Hz for one-third-octave bands, and at least 125 Hz to 4 000 Hz for octave bands.

NOTE 11 The preferred ranges are 50 Hz to 10 000 Hz for one-third-octave bands, and 63 Hz to 8 000 Hz for octave bands.

The octave- or one-third-octave-band sound pressure levels in the room for each loudspeaker position shall be measured in at least six fixed microphone positions distributed evenly around/above the cabin. The procedures specified in ISO 3741:1988, clause 7, shall be followed. (The requirements specified in ISO 3741:1988, subclause 7.1.3, concerning the distances between microphone positions and room surfaces are also valid for the distances between microphone positions and the external surfaces of the cabin.)

The average sound pressure level over different loudspeaker positions in the reverberation room shall be determined as an average value on a mean-square basis.

6.5 Measurement of the sound pressure level inside the cabin

6.5.1 Without a well-defined operator's position

No microphone position shall be closer to the internal cabin surfaces than 0,2 d, where d is the shortest inner dimension of the cabin. All positions shall be at least 1 m above floor level.

The sound pressure level for each loudspeaker position shall be measured in at least six fixed microphone positions or by use of a rotating microphone. Fixed microphones shall be distributed over the entire allowable volume as defined above. If a rotating microphone is used, the path shall cover a substantial portion of the allowable volume.

The measured sound pressure levels in the different microphone positions shall be averaged on a mean-square basis.

6.5.2 With a well-defined operator's position

For cabins with only one well-defined operator's position, the averaging volume is defined by the volume containing typical ear positions of an operator. If fixed microphones are used, three positions shall be distributed on a sphere with a radius of 0,3 m and the centre at the head-position of the operator. If a rotating microphone is used, the radius shall be 0,3 m and the centre of the circle shall be at the head-position of the operator. The path shall be inclined by 45° relative to the horizontal plane.

The measured sound pressure levels in the different microphone positions shall be averaged on a mean-square basis.

6.6 Sound pressure insulation, D_p

The sound pressure insulation in one-third-octave or octave bands, D_p, is given by

$$D_p = (L_p)_{\text{room}} - (L_p)_{\text{cabin}} \quad \ldots (1)$$

where

$(L_p)_{\text{room}}$ is the averaged sound pressure level, in decibels, in one-third-octave or octave bands in the room;

$(L_p)_{cabin}$ is the averaged sound pressure level, in decibels, in one-third-octave or octave bands inside the cabin.

6.7 Measurement of noise inside the cabin due to noise sources forming an integral part of the cabin
(internal noise level, L_{pA})

If the cabin includes noise sources (e.g. fans) installed as an integral part of the cabin, the A-weighted sound pressure level inside the cabin, L_{pA}, due to these shall be determined when the external noise sources in the room have been switched off.

For cabins with one or more well-defined operators' positions, the sound pressure level shall be measured at these positions according to the method specified in 6.5.2.

For cabins with no well-defined operators' positions, the sound pressure level shall be measured close to the middle of the cabin at three microphone positions on a sphere with radius 0,3 m or by averaging over a circular microphone path with a radius of 0,3 m. The path shall be inclined by 45° relative to the horizontal plane. The centre of the measurement sphere/circle shall be 1,55 m ± 0,075 m above floor level. The measurement result, L_{pA}, is the average value determined on a mean-square basis.

The background noise level inside the cabin (when integrated noise sources are switched off) shall be at least 6 dB and preferably more than 12 dB below the sound pressure level from the noise sources to be measured. If the difference is in the range 6 dB to 10 dB, the result of the measurement shall be corrected for the effect of the background noise in accordance with ISO 3741.

7 Measurement of sound insulation performance *in situ*

7.1 General

Two methods are specified, one where the sound field is generated by loudspeakers and one where the actual environmental noise is used. The loudspeaker method is preferred if the purpose of the *in situ* measurement is to achieve results comparable with laboratory results. The actual noise method is used to estimate the sound insulation performance of the cabin under actual conditions.

A sound field is generated in the room and the sound pressure level difference between the room and the inside of the cabin is measured.

These methods are applicable for *in situ* measurements in all types of rooms.

7.2 External sound field

If several possibilities exist for choosing a room for the measurement, select the room in which the best approximation of a reverberant sound field is expected. This normally means the room with the largest volume and the longest reverberation time.

7.2.1 Measurement with a loudspeaker

This method is preferred if the purpose of the measurement is to compare the sound insulation performance *in situ* with results of laboratory measurements.

The sound field shall be generated by a loudspeaker source using at least three different positions. The number of source positions shall be equal to or greater than the maximum deviation, in decibels, of D'_p between any two source positions using octave bands. The number of source positions shall be increased to a maximum of six. If the deviation, in decibels, in any octave band exceeds the maximum number of source positions (six), this shall be stated in the report.

If the requirement stated above cannot be fulfilled with three loudspeaker positions, then try with four positions. The three positions used first should not be used again for the measurement with four positions. If a further increase in number of positions is necessary, the same procedure should be used.

The distance between the loudspeaker positions shall be at least 3 m. The loudspeaker positions shall be uniformly distributed around the cabin. Either one loudspeaker cabinet can be moved between the chosen positions with the measurements carried out sequentially, or several loudspeakers can be operating simultaneously provided that they are incoherent (having a separate noise generator and power amplifier for each loudspeaker).

The average sound pressure level over different loudspeaker positions in the room shall be determined on a mean-square basis.

Care shall be taken to avoid any influence of the direct sound field from the sound source. The distance between the cabin and the sound source shall not be less than 2 m.

NOTE 12 The minimum distance of 2 m will be sufficient provided that the loudspeaker is approximately omnidirectional and that loudspeaker positions close to room surfaces or corners are avoided.

The generated sound shall be steady and have a continuous spectrum over the frequency range

considered. If the measurement is carried out using octave bands, the spectrum shall be approximately flat within each octave band. The three one-third-octave band levels within each octave band shall not differ by more than 6 dB in the octave band of 125 Hz, 5 dB in the band of 250 Hz, and 4 dB in the bands of higher frequencies. The output shall be sufficiently high to give a sound pressure level inside the cabin exceeding the background noise level by at least 6 dB and preferably more by than 12 dB for all frequency bands of interest. Correction for the influence of background noise shall be carried out as specified in ISO 3741.

For microphone positions, see 7.4 and 7.5.

7.2.2 Measurement with the actual environmental noise

This method is preferred if the purpose of the measurement is to evaluate the sound insulation performance of the cabin under actual conditions.

The actual noise should be diffuse and stable in time and space. If the noise varies in time, the measurements outside and inside the cabin shall be carried out simultaneously.

For a correct measurement to be performed, the sound pressure level over the entire frequency range shall be so high that any contribution from irrelevant noise sources is negligible inside the cabin. If practicable, the actual sound sources used for the measurement should be turned off and the background noise from irrelevant noise sources determined.

Correction for the influence of irrelevant noise sources shall be made as specified in ISO 3741. If the actual sound sources cannot be turned off, it shall be mentioned in the report that the magnitude of influence of irrelevant background noise is unknown and that the measurement result is a minimum value.

The averaging time in each microphone position shall be sufficiently long to be representative of the actual noise.

The purpose of measurements carried out *in situ* with the actual environmental noise is normally to evaluate the sound insulation performance in a specific situation. If the test results of measurements carried out in octave bands are intended in addition for use as general measures of the sound insulation performance, the spectrum of the actual environmental noise shall be approximately flat within each octave band. The requirements concerning the difference between one-third-octave band levels within each octave band given in 7.2.1 should be fulfilled. If this requirement cannot be fulfilled, measurements for general use should instead be carried out in one-third-octave bands.

For microphone positions, see 7.4 and 7.5.

7.3 Cabin mounting and conditions

The cabin shall be installed as specified by the manufacturer.

The cabin shall be empty during the measurements. Unless otherwise specified in the operating instructions for the cabin, the doors and windows shall be closed, active elements such as ventilating fans shall be switched off, and valves in the ventilation system shall be open when measuring the sound insulation performance. All movable parts of the cabin shall be operated at least 10 times before the measurement is carried out.

NOTE 13 A high degree of flanking transmission in the floor of the room may influence the measurement result (sound transmission from the room to the cabin through the floor).

7.4 Microphone positions in the room

The mean octave band, one-third-octave band or A-weighted sound pressure levels in the room for each loudspeaker position are determined by following the procedures specified in 6.4. Six microphone positions shall be used. The frequency range for one-third-octave bands shall be at least 100 Hz to 5 000 Hz, and for octave bands at least 125 Hz to 4 000 Hz.

NOTE 14 The preferred ranges are 50 Hz to 10 000 Hz for one-third-octave bands, and 63 Hz to 8 000 Hz for octave bands.

If the measurement is performed in a large room with a short reverberation time, the distance between any microphone position and the exterior cabin surfaces should not be more than 5 m.

The distance between any microphone position and the loudspeakers shall be at least 3 m.

7.5 Microphone positions inside the cabin

See 6.5.

7.6 Apparent sound pressure insulation, D'_p

The apparent sound pressure insulation, D'_p, in octave or one-third-octave bands is given by

$$D'_p = (L_p)_{\text{room}} - (L_p)_{\text{cabin}} \quad \ldots(2)$$

where

$(L_p)_{\text{room}}$ is the averaged sound pressure level, in decibels, in one-third-octave or octave bands in the room;

$(L_p)_{cabin}$ is the averaged sound pressure level, in decibels, in one-third-octave or octave bands inside the cabin.

The apparent A-weighted sound pressure insulation, D'_{pA}, is given by

$$D'_{pA} = (L_{pA})_{room} - (L_{pA})_{cabin} \quad \ldots(3)$$

where

$(L_{pA})_{room}$ is the A-weighted averaged sound pressure level, in decibels, of the actual environmental noise in the room;

$(L_{pA})_{cabin}$ is the A-weighted averaged sound pressure level, in decibels, in the cabin.

7.7 Measurement of noise inside the cabin due to noise sources forming an integral part of the cabin

If the cabin includes noise sources (e.g. fans), the A-weighted sound pressure level inside the cabin due to such noise sources shall be measured according to the method specified in 6.7.

8 Weighted sound pressure insulation

The weighted sound pressure insulation, $D_{p,w}$ or $D'_{p,w}$, is calculated in accordance with ISO 717-1.

ISO 717-1 specifies a method whereby the sound insulation in octave bands and one-third-octave bands is converted into a single-number value (the weighted sound reduction index) by comparing the measured values with a reference curve.

$D_{p,w}$ and $D'_{p,w}$ defined in this International Standard are determined in accordance with ISO 717-1 using D_p or D'_p instead of the sound reduction indexes which are the basic values used in ISO 717-1.

9 Estimated cabin noise insulation for a specific noise spectrum

If the actual noise is known or can be assumed, the reduction in A-weighted noise level due to the cabin can be estimated from D_p or D'_p using the method given in annex A.

10 Uncertainty

The sound pressure insulation, D_p, determined in the laboratory in conformity with this International Standard, is expected to yield deviations which, in the frequency range from 250 Hz to 10 000 Hz, are approximately equal to those given in ISO 3741 if the volume of the room is at least 20 times the volume of the cabin. At frequencies in the range from 50 Hz to 200 Hz and for measurements on large cabins where the ratio of 1/20 cannot be fulfilled, an increased measurement uncertainty is generally expected.

When determining the apparent sound pressure insulation, D'_p, *in situ* by means of the loudspeaker method, the standard deviation is expected to be about 2 dB larger than for measurements in the laboratory.

NOTE 15 The standard deviation mentioned above corresponds to that defined in ISO 3741.

For *in situ* measurements performed with the actual noise, no approximation of the measurement accuracy can be stated. If a declared value is given, it shall be verified in accordance with ISO 4871.

11 Information to be recorded

The following information, when applicable, shall be compiled and recorded for all measurements made according to the requirements of this International Standard.

11.1 Test object

a) Identification of the cabin (name/trademark).

b) Detailed description, preferably including drawings, of the cabin (panels, floor construction, windows, doors, joints between panels, ventilation system, valves, etc.).

c) Total mass of the cabin or mass per square metre of the panels.

d) Interior and exterior volume, area and dimensions.

e) Leak ratio and description of openings.

f) Description of the interior surfaces.

g) Description of the mounting of the cabin.

h) Method of sampling of the test object, and other circumstances such as the date and person responsible for the sampling.

i) Description of furnishings which are an integral part of the cabin.

11.2 Test conditions

a) Environmental data during the test (air temperature, barometric pressure, relative humidity, etc).

b) Description of the room used for the test, such as volume, dimensions, scattering, shielding objects and acoustical performance (e.g. reverberation time or equivalent absorption area).

c) Description of the positions of the test object, loudspeakers and microphones, preferably shown in a sketch of the room.

d) Description of the floor construction in the test room.

e) Description of the state (open/closed) of the windows, doors, valves, etc. during the measurement.

11.3 Instrumentation

Identification of the test equipment and instruments used.

11.4 Acoustical data

a) Test method.

b) Any deviation from the test method.

c) For measurements carried out in the laboratory, the following information shall be given:

— sound pressure insulation, D_p;

— internal noise level, L_{pA} (if relevant).

d) For measurements carried out *in situ*:

— apparent sound pressure insulation, D'_p;

— apparent A-weighted sound pressure insulation, D'_{pA}, if the actual noise has been used;

— internal noise level, L_{pA} (if relevant).

e) All measurement results shall be stated in decibels, rounded to the nearest integer.

f) The sound insulation performance given in one-third-octave or octave bands shall be given in the form of a table and, preferably, a graph. For graphs with the sound insulation performance in decibels plotted against frequency in hertz on a logarithmic scale, the length for a 10:1 frequency ratio shall be equal to the length of 25 dB on the ordinate scale. For results obtained according to this International Standard, it is preferable that one octave corresponds to 15 mm and 10 dB to 20 mm.

g) Measurement uncertainty.

11.5 Further information

a) Name and address of the testing laboratory.

b) Identification number of the test report.

c) Name and address of manufacturer or supplier of the test object.

d) Date of the test.

e) Signature of person carrying out the test.

12 Information to be reported

The information given in table 1 shall be contained in the report.

The test report shall contain a reference to this International Standard and, for laboratory measurements, also a reference to ISO 3741.

This International Standard contains a laboratory method as well as two different kinds of *in situ* methods. It is therefore important that the designation of the different methods in table 1 is used when referring to this International Standard to prevent misjudgement of an actual measurement result. For *in situ* measurements, it shall be clearly stated whether a loudspeaker or the actual noise was used as the sound source.

If the estimated cabin noise insulations $D_{pA,e}$ and $D'_{pA,e}$ are given (see annex A), the spectrum of the noise used for the calculation shall be reported.

If the measurement environment for laboratory measurements is not qualified for the whole frequency range in accordance with ISO 3741, the results may still be reported provided that frequencies outside the the range of qualification are clearly indicated.

The name and address of the testing laboratory and date of the test shall be reported.

Apart from the above-mentioned information, only data (see clause 11) required for the purposes of the measurements are to be reported.

Table 1 — Data to be reported

Laboratory method[1)]	***In situ* method**	
	Loudspeaker[1)]	**Actual noise**
D_p and, if relevant, L_{pA}	D'_p and, if relevant, L_{pA}	D'_p, D'_{pA} and, if relevant, L_{pA}
1) In addition, one or several of the single-number values $D_{p,w}$, $D'_{p,w}$, $D_{pA,e}$ and $D'_{pA,e}$ can be given.		

Annex A
(informative)

Estimated cabin noise insulation for a specific noise spectrum

An estimate of the reduction in the A-weighted sound pressure level due to the cabin, $D_{pA,e}$ or $D'_{pA,e}$, can be calculated using a known or assumed spectrum of the environmental noise (the actual noise) as follows:

$$D_{pA,e} = L_A - 10 \lg \sum_{i=1}^{n} 10^{0,1\,(L_i - A_i - D_{pi})} \text{ dB}$$

$$D'_{pA,e} = L_A - 10 \lg \sum_{i=1}^{n} 10^{0,1\,(L_i - A_i - D'_{pi})} \text{ dB}$$

where

L_A is the A-weighted sound pressure level, in decibels, of the environmental noise spectrum

$$\left[L_A = 10 \lg \left(\sum_{i=1}^{n} 10^{0,1\,(L_i - A_i)} \right) \text{ dB} \right];$$

L_i is the sound pressure level, in decibels, for frequency band i of the environmental noise spectrum;

n is the number of frequency bands used;

D_{pi} is the sound pressure insulation D_p, in decibels, for frequency band i;

D'_{pi} is the apparent sound pressure insulation D'_p, in decibels, for frequency band i;

A_i is the A-weighting attenuation for frequency band i.

For the purposes of the calculation, it is assumed that the sound field is diffuse. Differences between calculated and measured A-weighted sound pressure levels inside the cabin can occur because the sound field *in situ* will very often be non-diffuse. Possible contributions to the noise level inside the cabin from flanking transmission in the floor are not included in this calculation.

Annex B
(informative)

Bibliography

[1] ISO 3740:1980, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes.*

[2] ISO 11546-1:1995, *Acoustics — Determination of sound insulation performances of enclosures — Part 1: Measurements under laboratory conditions (for declaration purposes).*

[3] ISO 11546-2:1995, *Acoustics — Determination of sound insulation performances of enclosures — Part 2: Measurements* in situ *(for acceptance and verification purposes).*

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