SLOVENSKI STANDARD
SIST EN 20354:1998

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Akustika - Merjenje absorpcije zvoka v odmevnici (ISO 354:1985))

Acoustics - Measurement of sound absorption in a reverberation room (ISO 354:1985)

Akustik - Messung der Schallabsorption im Hallraum (ISO 354:1985)

Acoustique - Mesurage de l'absorption acoustique en salle réverbérante (ISO 354:1985)

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Descriptors: Acoustics, tests, acoustic tests, acoustic measurements, sound absorption coefficient, reverberation, rooms

English version

Acoustics - Measurement of sound absorption in a reverberation room (ISO 354:1985)

Acoustique - Mesurage de l'absorption acoustique en salle réverbérante (ISO 354:1985)

Akustik - Messung der Schallabsorption im Hallraum (ISO 354:1985)

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Foreword

This European Standard is the endorsement of ISO 354. Endorsement of ISO 354 was recommended by CEN/TC 126 "Acoustic properties of building products and of building", under whose competence the European Standard will henceforth fall.

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of an identical text or by endorsement, at the latest by December 1993, and conflicting national standards shall be withdrawn at the latest by December 1993.

The Standard was approved and in accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard : Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

Endorsement notice

The text of the International Standard ISO 354:1985 was approved by CEN as a European Standard without any modification.

International Standard 354

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Acoustics — Measurement of sound absorption in a reverberation room

Acoustique — Mesurage de l'absorption acoustique en salle réverbérante

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 354 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

It cancels and replaces ISO Recommendation R 354-1963, of which it constitutes a technical revision.

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Acoustics — Measurement of sound absorption in a reverberation room

0 Introduction

When a sound source operates in an enclosed space, the level to which reverberant sound builds up, and the subsequent decay of reverberant sound when the source is stopped, are governed by the sound-absorbing characteristics of the boundary surfaces and objects within the space. In general, the fraction of the incident sound power absorbed at a surface depends upon the angle of incidence. In order to relate the reverberation time of an auditorium, office, workshop, etc. to the noise reduction that would be effected by an absorbing treatment, a knowledge of the sound-absorbing characteristics of the surfaces, usually in the form of a suitable average over all angles of incidence, is required. Since the distribution of sound waves in typical enclosures includes a wide and largely unpredictable range of angles, it is convenient, for the purposes of standardization, to take a uniform distribution as the basic condition. If, furthermore, the sound intensity is independent of location within the room, such a distribution is called a diffuse sound field, and the sounds reaching a room surface are said to be at random incidence.

Measurements under reverberant conditions are necessary because, in this way, the effects of practical mounting conditions can be included. Furthermore, it is the only way to determine the sound absorption of discrete objects such as chairs, office landscaping screens, etc.

The purpose of this International Standard is to promote uniformity in the methods and conditions of measurement of sound absorption in reverberation rooms, so that values determined by different laboratories agree as closely as is possible at present. In order to improve precision, it may become necessary to limit further the variability of test conditions. The sound absorption data determined by the method described may be used for design calculations. In certain cases, however, deviations between predicted and measured values of reverberation time may occur.

It should be emphasized that, in order to attain the above objectives, a more diffuse sound field than the one which ordinarily exists in most rooms, auditoria, etc. is required, and certain other constraints, for example on the dimensions of the reverberation room, are necessary.

1 Scope and field of application

This International Standard specifies a method of measuring the sound absorption coefficient of acoustical materials used as wall or ceiling treatments, or the equivalent sound absorption area of objects, such as furniture, persons or space absorbers, in a reverberation room. It is not intended for measuring the absorption characteristics of weakly damped resonators.

The results obtained can be used for comparison purposes and for design calculation with respect to room acoustics and noise control.

2 References

ISO 5725, *Precision of test methods — Determination of repeatability and reproducibility by inter-laboratory tests.*

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

3 Definitions

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

3.1 reverberation time: The time that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped.

The quantity is denoted by T and is expressed in seconds.

NOTE — This definition is based on the assumption that, in the ideal case, there is a linear relationship between the sound pressure level and time and that the background noise level is sufficiently low.

3.2 equivalent sound absorption area of a room: The hypothetical area of a totally absorbing surface without diffraction effects which, if it were the only absorbing element in the room, would give the same reverberation time as the room under consideration.

For the empty reverberation room, this quantity is denoted by A_1; for the reverberation room containing a test specimen, it is denoted by A_2. The quantity is expressed in square metres.

3.3 equivalent sound absorption area of a test specimen: The difference between the equivalent sound ab-

sorption area of the reverberation room with and without the test specimen.

The quantity is denoted by A and is expressed in square metres.

3.4 sound absorption coefficient: The change in equivalent sound absorption area after placing a test specimen in the reverberation room, divided by the area of the test specimen.

It is only defined for a plane test specimen and is denoted by α_S.

NOTE — When evaluating the sound absorption coefficient from measurements in a reverberation room, the results should be denoted by the subscript "S". The use of this subscript avoids confusion with the sound absorption coefficient defined as the ratio of non-reflected-to-incident sound energy if a plane wave strikes a plane wall at a particular angle of incidence. This "geometric" sound absorption coefficient is always smaller than unity and may therefore be expressed as a percentage. The sound absorption coefficient evaluated from reverberation time measurements may have values larger than unity, for example due to diffraction effects, and α_S shall not, therefore, be expressed as a percentage.

3.5 repeatability, r: The value below which the absolute difference between two single test results obtained using the same method on identical test material, under the same conditions (same operator, same apparatus, same laboratory and a short interval of times) may be expected to lie with a specified probability; in the absence of other indications, the probability is 95 %.

3.6 reproducibility, R: The value below which the absolute difference between two single test results obtained using the same method on identical test material, under different conditions (different operators, different apparatus, different laboratories and different times), may be expected to lie with a specified probability; in the absence of other indications, the probability is 95 %.

4 Principle

Measurement of reverberation times in a reverberation room, with and without the test specimen. From these times, calculation of the equivalent sound absorption area A of the test specimen.

In the case of a plane test specimen, the sound absorption coefficient is obtained by dividing A by its surface area S.

When the test specimen comprises several identical objects, the equivalent sound absorption area of an individual object is found by dividing A by the number of objects.

5 Apparatus

The apparatus shall be such that the requirements given in clause 7 are met.

6 Test arrangement

6.1 Reverberation room and diffusion of sound field

6.1.1 Volume of reverberation room

The volume of the reverberation room shall be at least 150 m^3. For new constructions, the volume shall be approximately 200 m^3.

6.1.2 Shape of reverberation room

The shape of the reverberation room should be such that the following condition is fulfilled:

$$l_{max} < 1{,}9\ V^{1/3}$$

where

l_{max} is the length of the longest straight line which fits within the boundary of the room (for example, in a rectangular room, it is the major diagonal);

V is the volume of the room.

In order to achieve a uniform distribution of natural frequencies, especially in the low-frequency bands, no two dimensions of the room shall be equal or in the ratio of small whole numbers.

NOTE — In the case of non-rectangular rooms where the test specimen is placed on the floor, the results will agree more closely with results from rectangular rooms if the non-vertical walls slant inwards.

6.1.3 Diffusion of sound field

The decaying sound field in the room shall be sufficiently diffuse. In order to achieve satisfactory diffusion, whatever the shape of the room, the use of stationary, suspended diffusers or of rotating vanes is, in general, required (see annex A).

6.1.4 Sound absorption area

The equivalent sound absorption area A_1 of the empty room, determined in one-third octave bands, shall not exceed the values given in table 1.

Table 1 — Maximum equivalent sound absorption areas for room volume V = 200 m^3

Equivalent sound absorption area, m^2	6,5	6,5	6,5	7,0	9,5	13,0
Frequency, Hz	125	250	500	1 000	2 000	4 000

If the volume V of the room differs from 200 m^3, the values given in table 1 shall be multiplied by the factor $(V/200)^{2/3}$.

The graph of the equivalent sound absorption area of the empty room versus frequency should be a smooth curve and should have no dips or peaks differing by more than 15 % from the mean of the values of both adjacent one-third octave bands.

6.2 Test specimen

6.2.1 Plane absorbers

6.2.1.1 The test specimen shall have an area between 10 and 12 m^2. If the volume V of the room is greater than 250 m^3, the normal test specimen area shall be increased by the factor $(V/250)^{2/3}$.

NOTE — For the testing of materials with exceptionally small sound absorption coefficients, it is recommended that test specimens with an area larger than specified be used in order to obtain a significant difference between the measured reverberation times T_1 and T_2 (see 8.1.2).

6.2.1.2 The test specimen should be of rectangular shape with a ratio of width to length between 0,7 and 1. It shall be placed so that no part of it is closer than 1 m to any edge of the boundary of the room. The edges of the test specimen should preferably not be parallel to the nearest edge of the room.

6.2.1.3 The test specimen shall be mounted in accordance with the relevant specifications provided by the producer or with the application details provided by the user.

In the case of a test specimen directly mounted on a room surface, the edges shall be totally and tightly enclosed by a frame constructed from reflective material of rectangular cross-section and, in general, of thickness not greater than 2 cm. The frame shall not protrude above the surface of the test specimen. It shall be tightly sealed to the room surface on which it is mounted.

In the case of a test specimen backed by an airgap, for instance to simulate a suspended ceiling, sidewalls shall be constructed perpendicular to the test surface. The sidewalls shall enclose both the airgap and the test specimen edges, and shall be highly reflective.

NOTES

1 The measurement of the reverberation time of the empty room should be made in the absence of the frame or the sidewalls of the test specimen.

2 As an alternative, in the case of test specimens backed by an airgap, the test specimen can be mounted in a recess in one of the boundaries of the reverberation room. It is, however, possible that this method will not give the same results as the method specified.

6.2.2 Discrete sound absorbers

6.2.2.1 Discrete objects, for example chairs, persons, space absorbers, shall be installed for test in the same manner as they are typically installed in practice. For example, chairs or freestanding screens shall rest on the floor, but they shall not be closer than 1 m to any other boundary. Space absorbers shall be mounted at least 1 m from any boundary or room diffusers and at least 1 m from any microphone.

6.2.2.2 A test specimen should comprise a sufficient number of individual objects (in general, at least three) to provide a measurable change in the equivalent sound absorption area of the room greater than 1 m^2, but not more than 12 m^2. If the volume V of the room is greater than 250 m^3, these vaiues shall be increased by the factor 12 $(V/250)^{2/3}$.

Objects normally treated as individual objects should be arranged randomly, spaced at least 2 m apart. If the test specimen comprises only one object, it should be tested in at least three locations, at least 2 m apart, and the results averaged.

6.2.2.3 If the test specimen comprises a given array of objects (for example theatre chairs, noise absorber pads), they shall be installed for test in this configuration. When testing groups of seats with seated persons, the edges of the arrangement shall be enclosed by reflecting material. This enclosure should have a height of up to 1 m. In other cases, the height of the enclosure should be adapted to the height of the test specimen.

6.2.3 Curtains

Curtains tested against walls can be treated as plane absorbers (6.2.1) if closed, or as discrete absorbers (6.2.2) if open. In the former case, the edges shall be enclosed. The requirements for a minimum distance of 1 m from the walls or from the edges do not apply in the case of curtains.

6.3 Temperature and relative humidity

The relative humidity in the room shall be greater than 40 %. During a series of measurements of reverberation times T_1 and T_2 (see 8.1.2), the relative humidity and the temperature should be as constant as possible and at least the conditions given in table 2 should be satisfied.

Table 2 — Requirements for temperature and relative humidity during measurements of T_1 and T_2

Relative humidity range	Relative humidity during all measurements within	Temperature during all measurements within	Lower temperature limit
40 up to 60 % > 60 %	3 % 5 %	3 °C 5 °C	10 °C 10 °C