AS 1045—1988

Australian Standard®

ACOUSTICS—MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM

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Association of Australian Acoustical Consultants
Australian Acoustical Society
Australian Broadcasting Corporation
Australian Environment Council
Building Management Authority, W.A.
Confederation of Australian Industry
National Building Technology Centre
Public Works Department, N.S.W.
Royal Australian Institute of Architects
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PREFACE

This Standard was prepared by the Association's Committee on Acoustics—Architectural to supersede AS 1045—1971, *Method of measurement of absorption coefficients in a reverberation room*. It is based on ISO 354—1985, *Acoustics—Measurement of sound absorption in a reverberation room*, but it contains some technical changes which are significantly different from the corresponding provisions of ISO 354. The main deviation from ISO 354 concerns the level of precision (hence repeatability) to which laboratories should be allowed to work when performing tests. In cases where a laboratory must be permitted a choice from a range of a variable that affects precision, ISO 354 has no mandatory adjustment required for the number of decays to be performed in an attempt to compensate for the variation in precision caused by the choice made.

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FOREWORD

The purpose of this 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 to the greatest extent possible. In order to achieve an improved precision, it may become necessary to limit further the variability of test conditions.

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, e.g. on the dimensions of the reverberation room, are necessary. Although the sound absorption data determined by this method are intended for use in design calculations, deviations between predicted and measured values of reverberation time may occur in typical rooms, auditoria, etc, where the sound field is less diffuse than in the laboratory.

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 predict the change in reverberation time or the noise reduction that would be effected by an absorbing treatment of an auditorium, office, workshop, etc, a knowledge of the sound absorption characteristics of the surfaces, usually in the form of a suitable average over all angles of incidence, is required. The distribution of sound waves in typical enclosures includes a wide and largely unpredictable range of angles, but 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. However, the placement of a highly absorbing sample in a reverberation room will itself reduce the diffusion that existed in the empty room.

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.

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SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This Standard sets out 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.

1.2 APPLICATION. The results obtained, using the method outlined in this Standard, can be used for comparison purposes and for design calculation with respect to room acoustics and the reduction of the reverberant component of the sound field.

1.3 PRINCIPLE OF THE METHOD. The method requires measurement of reverberation times in a reverberation room as a function of frequency, with and without the test specimen, denoted $T_{60,e+s}$ and $T_{60,e}$ respectively. From these reverberation times, the equivalent sound absorption area (A_s) of the test specimen is calculated.

For a plane test specimen, the sound absorption coefficient is obtained by dividing the equivalent sound absorption area (A_s) 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_s by the number of objects.

1.4 STANDARD DEVIATION OF MEASUREMENTS. Information on the standard deviations of repeatability and of reproducibility, expected to be observed among measurements made to the requirements of this Standard, is given in Appendix B.

1.5 REFERENCED DOCUMENTS. The documents below are referred to in this Standard.

AS
1633 Acoustics—Glossary of terms and related symbols

Z41 Octave, half octave and one-third octave band pass filters intended for the analysis of sounds and vibrations

1.6 DEFINITIONS. For the purpose of this Standard, the definitions given in AS 1633 and those below apply.

1.6.1 Reverberation time—the time required for the sound pressure level to decrease by 60 dB after the sound source has stopped.

The quantity is denoted by T_{60} and is expressed in seconds.

NOTE: For the purpose of this Standard, it is assumed that the value of T_{60} may be determined from the inverse of the mean rate of decay of sound pressure level over a range of approximately 30 dB in the early part of the decay of level, the background level being sufficiently low to avoid interference.

1.6.2 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 in that room.

For the empty reverberation room, this quantity is denoted by A_e; for the reverberation room containing a test specimen, it is denoted by A_{e+s}. The quantity is expressed in square metres.

1.6.3 Equivalent sound absorption area of a test specimen—the difference between the equivalent sound absorption area of the reverberation room with (A_{e+s}) and without (A_e) the test specimen.

The quantity is denoted by $A_s = (A_{e+s} - A_e)$ 1.6.3(1)

1.6.4 Sound absorption coefficient—the equivalent sound absorption area of a test specimen divided by the area (S) covered by the test specimen.

The quantity is denoted by α_s.

It is defined only for specimens of materials intended for covering solid surfaces having dimensions that are large compared with the overall material thickness. When the specimens are mounted for test on one of the plane test room boundaries, S is taken as the area of the plane covered, not the total frontal area of the specimen, which may be deeply grooved or modelled.

NOTE: When the sound absorption coefficient from measurements in a reverberation room are being evaluated, 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, e.g. due to diffraction effects, and α_s should not be expressed as a percentage.

1.6.5 Repeatability standard deviation (s_r)—the standard deviation of a number of complete standard measurements of α_s or A_s of a test specimen, repeated in one laboratory, by the same operator, using the same room, apparatus and procedure each time. It is assumed that variables such as microphone position, source position, specimen position (for discrete absorber) and particular burst of random noise, which this Standard leaves for the operator to choose randomly as part of the procedure of a measurement, would be chosen afresh for each of the repeated measurements.

1.6.6 Reproducibility standard deviation (s_R)—the standard deviation of a number of complete standard measurements of α_s or A_s of a material, the measure-