AS 2460—1981

Australian Standard®

ACOUSTICS — METHOD FOR THE MEASUREMENT OF REVERBERATION TIME IN ENCLOSURES

The following, scientific, industrial and governmental organizations and departments were officially represented on the committee entrusted with the preparation of this standard:

Australian Acoustical Society

Confederation of Australian Industry

CSIRO, Division of Building Research

Department of Science and Technology

Environment Protection Authority, Victoria

Experimental Building Station

Institution of Engineers, Australia

Public Works Department, Western Australia

Royal Australian Institute of Architects

Royal Melbourne Institute of Technology

Universities

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PREFACE

This standard was prepared by the Association's Committee on Architectural Acoustics, and is based on ISO 3382, Acoustics—Measurement of Reverberation Time in Auditoria.

One of the important measures of the acoustic performance of an enclosure is the average rate at which the sound pressure level in the enclosure decays with time after the source of sound stops emitting. Traditionally this is expressed as the reverberation time, i.e. the time taken for the level to decay by 60 dB. Often in field measurements, only the first 30 d B or so of such decays is available for analysis, but the slope of this part of the decay record probably has greater influence on the subjective experience of the acoustics of the enclosure than the slope of the later parts. Consequently, measurement procedures in this standard are restricted to the first 30 dB of the decay of the sound pressure level, although the result is still expressed in terms of the equivalent reverberation time for 60 dB of decay.

In this standard, the response characteristics of the recording systems are set at values designed to smooth the decay record appropriately for the determination of a single unbiased average value for the reverberation time from the first 30 dB of the smoothed decay record; or at best the detection and determination of two significantly different reverberation times should they exist in different parts of this range. Although with different settings and evaluation procedures it may be feasible using similar instrumentation to resolve and measure finer detail of the transient response of an enclosure, such measurements are beyond the scope of this standard.

The title of the standard implies that a single method is specified; however, it will be noted that two forms of excitation are permitted, viz a prolonged burst of broad-band or band-limited noise, and a single brief impulsive sound. There is some evidence that with the types of instrumentation and evaluation procedures specified in the standard, the results obtained by the two forms of excitation may differ significantly in some enclosures.

This standard requires reference to the following Australian standards:

AS 1045 Method of Measurement of Absorption Coefficients in a Reverberation Room

AS 1259 Sound Level Meters
Part 2 — Type 2, Precision

AS 1633 Glossary of Acoustic Terms

AS Z33 Preferred Frequencies and Band Centres for Acoustical Measurements

AS Z41 Octave, Half Octave and One-third Octave Band Pass Filters Intended for the Analysis of Sound and Vibrations

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STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard
for
ACOUSTICS — METHOD FOR THE MEASUREMENT OF REVERBERATION TIME IN ENCLOSURES

FOREWORD

At present, several methods exist for the measurement of reverberation time and there are some new ideas in this field. Each of these methods may give a different result for the same enclosure. The reasons for such differences lie in the different types of signal employed as well as in the methods of recording the decay of sound.

This standard specifies performance requirements for the instrument systems and techniques used for recording, displaying and evaluating reverberation sound decays, and these can be met by the majority of systems and techniques currently in use in Australia. These requirements are designed to minimize differences of results arising from the use of different instruments or different settings.

By permitting the use of alternative forms of excitation signal in certain circumstances (steady-state or impulsive) under appropriately standardized conditions, this standard makes it possible to compare data obtained from the two forms of excitation. When sufficient results of standardized comparisons are available, it may be necessary to amend the standard in terms of using only one preferred form of excitation.

METHOD

1 SCOPE. This standard sets out a method for the measurement of reverberation time in enclosures.

2 APPLICATION. This standard applies to the assessment of the acoustic performance of enclosures including auditoriums.

NOTE: This standard is not intended to be used for the measurement of the absorption coefficients of materials for which reference should be made to AS 1045.

3 DEFINITIONS. For the purpose of this standard, the following definitions apply:

NOTE: For definitions of other acoustic terms, see AS 1633.

3.1 Reverberation time (*T*) (of an enclosure in a given frequency band) — the time required for the average sound energy density in the enclosure to decrease to 10^{-6} of the initial value, i.e. by 60 dB, after the source is stopped.

NOTE:

1. For the purpose of this standard, the reverberation time may be derived from measurement of only the first 30 dB of decay of sound pressure level, at a number of points in the enclosure. A single representative figure may be obtained from the average of the reverberation times so measured at individual points.
2. The reverberation time determined over points in one part of an enclosure may differ from the reverberation time determined in other parts of the enclosure. The purposes of the measurement may extend to determining these differences in local reverberation times, rather than merely determining a single representative reverberation time for the whole enclosure.

3.2 States of Occupancy for Enclosures (Other than Auditoriums).

(a) *Empty state* — the state of the enclosure prepared for intended use and ready for the intended use by prospective users but without those users present.

(b) *Occupied state* — the state of the enclosure occupied by intended users of the enclosure, where their number corresponds to the usual number.

NOTES:

1. An accurate description of the state of occupancy of the enclosure is of decisive importance in the assessing of the results obtained by measurement of the reverberation time.
2. The enclosure may he regarded as ‘occupied’ when 80 percent to 100 percent of the design capacity of the enclosure is occupied.

3.3 States of Occupancy for Auditoriums.

(a) *Empty state* — the state of the auditorium prepared for a performance and ready for receiving performers and public, but without these persons present.

(b) *Studio state* — the state of the auditorium occupied by the performers only (without public), e.g. at rehearsals or during sound recordings, where the number of performers and other persons, such as technicians correspond to the usual number.

(c) *Occupied state* — the state of the auditorium with the performers and the public, where the number of persons corresponds to the usual number.

NOTES:

1. An accurate description of the state of occupancy of the auditorium is of decisive importance in assessing the results obtained by measurement of the reverberation time.
2. The auditorium may be regarded as ‘occupied’ when 80 percent to 100 percent of the auditorium seats are occupied. The presence of a choir may constitute an extraordinary occupancy, above the normal value. Furthermore, the number of members of the orchestra is to correspond to the usual number.
3. In theatres, a distinction is made between ‘safety curtain up’ and ‘safety curtain down’ and between ‘orchestra pit open’ and ‘orchestra pit closed’, and also between ‘orchestra seated on the stage’ with and without concert enclosure. In all these cases, measurement may be useful. If the safety curtain is up, the amount of furnishing of the stage is of importance and should be described.

4 PROCEDURE FOR MEASUREMENT OF REVERBERATION TIME IN ENCLOSURES.

4.1 General. The measurement of reverberation time may be made with the enclosure in the empty state or the occupied state, or, in the case of an auditorium also in the studio state. The temperature and relative humidity of the air in the enclosure shall be measured and recorded with instruments capable of measurements to an accuracy of ± 1°C for temperature and ± 3 percent for relative humidity.

4.2 Enclosure in Empty State.

4.2.1 *Sound source.* The sound source shall be one of the following:

(a) The sound may be generated by one or more loudspeakers which shall be as omni-directional as possible. The signal to the loudspeaker shall be derived from broad-band random or pseudorandom electrical noise.

Filters complying with AS Z41, with bandwidths of either one octave or one-third octave, may be used to limit the bandwidth of the signal proceeding to the loudspeaker, with the reverberation time being measured sequentially in different frequency bands.

Alternatively, the broad-band noise spectrum may be shaped to provide an approximately pink spectrum of steady-state reverberant sound in the enclosure from 90 Hz to 5700 Hz, with the reverberation time being measured simultaneously in different frequency bands.

NOTE: Broad-band noise excitation puts more severe requirements on the power handling capability of the loudspeaker system to maintain a given margin over background noise.

(b) In churches and concert halls, an organ may be used as the sound source. In order to excite as many room modes as possible, all semitones in each corresponding frequency range shall be played.

NOTE: Care should be taken that the decay time of the source itself does not significantly affect the result.

(c) Impulsive broad-band sound sources such as pistol shots, bursting balloons and other powerful impulsive sources that are not themselves reverberant may be used.

NOTE: Where an impulse is used, care should be taken that there are sufficiently high sound pressure levels at both low and very high frequencies. Therefore, it is advisable that before measurement is made in the auditorium, a frequency analysis of the impulse should be carried out in the laboratory, e.g. in a reverberation chamber.

In each of the foregoing cases, the sound source shall produce a maximum sound pressure level at least 40 dB above the background level in the corresponding frequency band, to minimize errors caused by background noise.

NOTE: Appendix A gives typical systematic errors caused by background noise.