

Australian Standard[®]

**ACOUSTICS—METHODS OF
ASSESSING AND PREDICTING
SPEECH PRIVACY AND SPEECH
INTELLIGIBILITY**

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Australian Acoustical Society
Confederation of Australian Industry
CSIRO Division of Building Research
Department of Employment and Industrial Relations
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STANDARDS AUSTRALIA

RECONFIRMATION

OF

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Acoustics—Methods of assessing and predicting speech privacy and speech intelligibility

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NOTES

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PREFACE

This standard was prepared by the Association’s Committee on Architectural Acoustics. It describes objective and subjective methods of estimating speech intelligibility and predicting speech privacy and applies to the determination of speech intelligibility in auditoriums, class rooms, lecture rooms, conference rooms, etc, and speech privacy conditions in offices, conference rooms, hotels, motels, dwellings, and schools.

The results obtained using the methods in this standard should be used with caution because of their limitations.

During the preparation of this standard reference was made to ANSI S3.14—1977, Rating Noise With Respect to Speech Interference.

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STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard

for

**ACOUSTICS—METHODS OF ASSESSING AND PREDICTING SPEECH
PRIVACY AND SPEECH INTELLIGIBILITY**

FOREWORD

Speech intelligibility and privacy depend on many factors, including acoustic factors, such as—

- (a) the level of the speech signal, its frequency spectrum;
- (b) space characteristics, such as reverberation and ambient sound level;
- (c) non-acoustic factors, such as the type of message, talker and listener characteristics, choice of test material, etc; and
- (d) random and quasi-random factors, such as individual differences between talkers and listeners, the effect of randomization of speech test material, etc.

Because of the above factors, caution should be exercised in the application of this standard and the results therefrom.

The following objective and subjective methods of predicting or assessing speech communication and speech privacy are described in this standard:

- (i) *Objective methods of predicting speech communication.*
 - A. Determination of the speech interference level (*SIL*) of an ambient sound and relating this to the maximum distance over which it is estimated that reliable speech communication may take place.
 - B. Determination of the overall ambient sound pressure level, in decibels(A), and relating this to the maximum distance over which it is estimated that reliable speech communication may take place.
 - C. Determination or prediction of the articulation index (*AI*) and relating this to the possibility of understanding connected speech.
- (ii) *Subjective method of assessing speech communication.* Direct measurement of the percentage speech intelligibility (*SI*) using a test crew of talkers and listeners and selected speech material and relating this to the possibility of understanding connected speech.
- (iii) *Objective method of predicting speech privacy.* Prediction of the estimated acceptability of the acoustic environment with respect to speech privacy, account being taken of such factors as vocal effort, source and receiving area characteristics, attenuation between source and receiving area, and ambient sound pressure level in the receiving area.
- (iv) *Subjective method of assessing speech privacy.* Direct measurement of the percentage speech intelligibility (*SI*) using a test crew of talkers and listeners and selected speech material, and relating this to the articulation index (*AI*) and thence to an assessment of the degree of speech privacy.

The acceptability of a speech communication/privacy condition depends on the conditions being investigated and in particular on the type of message being communicated. The greater the redundancy of information content in an ensemble of messages, the greater will be the intelligibility of communication in a particular acoustic environment. Conversely, lack of familiarity with a language, or with the vocabulary used on the part of the talker and/or listener, or the presence of a hearing disability in the listener, will have a significant effect on the acceptability or otherwise of a communication environment.

Generally speech levels vary widely for different talkers and a standard deviation of 6 dB is typical, thus both speech communication and speech privacy may be significantly altered according to the individual talker's speech level. Speech communication is also affected by the clarity of enunciation and speed of delivery of individual talkers. For speech privacy, the nature of the task performed by the listener will also affect the acceptability of the situation.

METHODS

1 SCOPE. This standard sets out objective methods for predicting the attainability of, and subjective methods for assessing actual attainment of, both reliable speech communication and speech privacy, in a given environment.

2 APPLICATION. This standard applies to—

- (a) speech communication in various spaces such as intelligibility in auditoriums, class rooms, conference rooms, and offices; and
- (b) speech privacy conditions in various spaces such as offices, conference rooms, hotels, motels, dwellings, and schools.

It may also be used to assess intelligibility of a voice reinforcement system in an auditorium.

It is not intended to apply to the assessment of electronic communication systems.

3 REFERENCED DOCUMENTS. The following documents are referred to in this standard:

AS 1259	Sound Level Meters
AS 1276	Methods for Determination of Sound Transmission Class and Noise Isolation Class of Building Partitions
AS 1633	Glossary of Acoustic Terms and Related Symbols
AS 2253	Methods for Field Measurement of the Reduction of Airborne Sound Transmission in Buildings
AS 2460	Acoustics—Measurement of Reverberation Time in Enclosures
AS Z41	Octave, Half Octave and One-third Octave Band Pass Filters Intended for the Analysis of Sound and Vibrations
SAA MP44	Guide for the Use of Sound Measuring Equipment Part 1—Portable Sound Level Meters*
ISO 6189	Acoustics—Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation Purposes
ANSI S3.5	Methods for the Calculation of the Articulation Index

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

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

4.1 Speech intelligibility (*SI*)—the number of correctly perceived speech signals compared with the total speech signals presented, expressed as a percentage.

4.2 Speech interference level (*SIL*)—the arithmetic average of the sound pressure levels of the ambient sound, in decibels re 20 μ Pa, in the four octave bands centred on the frequencies 500, 1000, 2000 and 4000 Hz.

NOTE: An earlier definition of *SIL* did not include the octave band centred on 4000 Hz (Ref. 1).

4.3 Articulation index (*AI*)—the representation of the effective proportion of normal speech signal level that is available to a listener above the ambient sound

and is a fraction determined over the 16 one-third octave bands centred on frequencies from 200 Hz to 6300 Hz, weighted for the contribution of each band to speech intelligibility.

4.4 Speech privacy (*SP*)—the potential of a combination of acoustical factors, including speech level, attenuation, ambient sound pressure level, and introduced masking sound (if present), to render intelligible speech within one area unintelligible in another area, ranked on a semantic scale.

4.5 Reverberation time of an enclosure in a given frequency band (T_{60})—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 has stopped.

4.6 Phoneme—the smallest distinguishable acoustic element of speech in a given language. Phonemes can be categorized into two general classes known as vowels V, and consonants C.

4.7 Syllable—a pronounceable unit of speech consisting of a vowel or a combination of a vowel with one or more consonants.

5 INSTRUMENTATION

5.1 Sound level meter. Measurements shall be made with a sound level meter complying with AS 1259. The A-weighting or the linear networks shall be used. Where octave band or one-third octave band measurements are made, the filter set shall comply with AS Z41.

NOTE: For convenience, other devices, such as tape recorders, statistical analysers, etc, may be included in the measurement chain. However, the inclusion of such devices will degrade the performance of the overall measurement chain.

5.2 Use of the sound level meter. The sound level meter and filters (if required) shall be used in accordance with the manufacturer's instructions (see also SAA MP44, Part 1). The sound level meter shall be checked for accuracy of indication with a pistonphone or a similar portable acoustic calibrator immediately prior to and after measurements; the sound level meter shall not be switched off at any time between the initial and final check. If the sound level meter registers a discrepancy greater than 1 dB between consecutive checks, any measurements carried out in the interval between the two checks shall be considered invalid.

6 OBJECTIVE METHODS OF PREDICTING SPEECH COMMUNICATION

6.1 General. Three objective methods for predicting the potential for speech communication in a given acoustic environment are described in Clauses 6.2 to 6.4 as follows:

- (a) Determination of the speech interference level (*SIL*)—Clause 6.2.
- (b) Determination of the A-weighted ambient sound level (L_A)—Clause 6.3.
- (c) Determination of the articulation index (*AI*)—Clause 6.4.

* SAA MP 44, Part 1 is currently under review and will be reissued as AS 2659.1.