



Acoustics—Description and measurement of environmental noise



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- Association of Australian Acoustical Consultants
 - Australian Acoustical Society
 - Austroads
 - Bureau of Steel Manufacturers of Australia
 - Department of Defence (Australian Government)
 - Engineers Australia
 - National Acoustic Laboratories
 - University of Sydney
-

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Australian Standard®

Acoustics—Description and measurement of environmental noise

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PREFACE

This Standard was prepared by the Australian Committee EV-010, Acoustics, Community Noise, to supersede AS 1055.1—1997, *Acoustics—Description and measurement of environmental noise, Part 1: General procedures*, AS 1055.2—1997, *Acoustics—Description and measurement of environmental noise, Part 2: Application to specific situations*, and AS 1055.3—1997, *Acoustics—Description and measurement of environmental noise, Part 3: Acquisition of data pertinent to land use*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard. The previous three-part AS 1055 series has been consolidated into this single document.

The objective of this Standard is for use in the evaluation of environmental noise in order to meet the needs of public bodies and persons interested in its management. It applies primarily to noise emitted from industrial, commercial and residential premises, and is intended for use in the evaluation of existing problems, as well as for planning purposes. It may be used for noise that includes impulsive components, but it is not suitable for noise that consists solely of discrete impulses (e.g. shooting, blasting).

The objective of this revision is to reflect the technological advances in acoustical measurement techniques since the previous revision of 1997 and different approaches taken by regulatory authorities in Australia to the measurement and assessment of environmental noise.

This Standard is not a regulatory document and users should identify the relevant requirements of regulatory authorities and the details of specific requirements laid down in each State or Territory.

It has been assumed that the user of this Standard is adequately trained in the science of acoustics and thoroughly experienced in noise measurement and assessment, but to familiarize the user with some of the special terms introduced in this Standard, an example of its application is included (see Appendix A).

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendices to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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Appendix E has been reprinted, with permission, from Torben Holm Pedersen: Amendment to ‘Audibility of Impulsive Sounds in Environmental Noise’ in *Inter-Noise 2000 Proceedings*, DELTA AV1533/00.

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FOREWORD

Although a sound level meter set on A-weighting and 'F' response may be used to make a quick assessment of a possible community noise problem, more sophisticated instrumentation is available and should be used for the purposes of this Standard. A choice may be made between the time average A-weighted sound pressure level ($L_{Aeq,t}$) or other descriptor(s) such as the percent exceedance A-weighted sound pressure level ($L_{A90,T}$) as the basic quantity, or other quantities as specified by the relevant regulatory authority.

The methods and procedures described in this Standard are intended to be applicable to sounds from all sources, individually and in combination, which contribute to the total noise at a site. For certain types of sources, more detailed procedures may be used (for example, the AS/NZS 1269 series, *Occupational noise management*, for situations where the noise may cause hearing impairment). Specific measurements for road traffic, aircraft and ship noise are covered in AS 2702, *Acoustics—Methods for the measurement of road traffic noise*, AS 2021, *Acoustics—Aircraft noise intrusion—Building siting and construction* and AS 1949, *Acoustics—Measurement of airborne noise emitted by vessels in waterways, ports and harbours* and AS 3671, *Acoustics—Road traffic noise intrusion—Building siting and construction* respectively.

This Standard aims at providing authorities with material for the description of noise in community environments. Based on the principles described in this Standard, acceptable limits of noise may be specified and conformance with these limits can be assessed.

STANDARDS AUSTRALIA

Australian Standard

Acoustics—Description and measurement of environmental noise**1 SCOPE**

This Standard sets out general procedures for the description and measurement of environmental noise, including repetitive impulsive noise. It defines the basic quantities to be used for the description of noise in community environments and provides basic procedures for the determination of these quantities.

The Standard applies primarily to noise emitted from industrial, commercial and residential premises. It excludes the setting of environmental noise criteria. Such levels are set by regulations or organizational policy.

This Standard does not apply to the following:

- (a) The measurement or assessment of in-transit air, rail or water transportation or road transportation on public roads (which may be present in the ambient noise occurring at a location).
- (b) Noise that consists solely of discrete impulses such as those encountered in shooting and blasting.
- (c) Noise from wind farms.

In this Standard, all sound pressure level descriptors are A-weighted, unless stated otherwise.

NOTE: Guidelines for the application of this Standard are given in Appendix A.

The structure of this Standard is as follows:

- (i) Definitions and symbols.
- (ii) Instrumentation.
- (iii) Measurements—
 - (A) general locations, times, conditions and methods for general measurements;
 - (B) methods for assessing specific environmental noise situations;
 - (C) methods for setting objectives and specifications; and
 - (D) methods for assessing conformance to objectives and specifications.
- (iv) Reporting and information to be recorded.
- (v) Appendices.

2 NORMATIVE DOCUMENTS

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

The following are the normative documents referred to in this Standard:

AS IEC	
61672	Electroacoustics—Sound level meters
61672.1	Part 1: Specifications
IEC	
60942	Acoustics—Sound calibrators

3 DEFINITIONS

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

3.1 Adjusted percent exceedance A-weighted sound pressure level ($L_{A\%,adj,T}$)

The A-weighted sound pressure level that is exceeded for the percent exceedance under consideration for the time interval considered, plus specified adjustments for tonal character and impulsiveness of sound.

3.2 Ambient sound

The totally encompassing sound in a given situation at a given time, composed of sound from all sources near and far, measured by the totally encompassing time average A-weighted sound pressure level in a given situation at a given time.

3.3 A-weighted sound pressure (p_A)

The root-mean-square (r.m.s.) sound pressure determined by use of frequency-weighting network 'A'.

NOTE: For the definition of A-weighting, refer to AS IEC 61672.1.

3.4 A-weighted sound pressure level (L_{pA})

The sound pressure, in decibels, as given by—

$$L_{pA} = 10 \log_{10} (p_A/p_o)^2 \quad \dots 3.4$$

NOTES:

- 1 In this Standard, most sound pressure level descriptors are A-weighted; however, there may be a requirement to measure C-weighted sound levels for sources with significant low-frequency energy or Z-weighted spectrum levels.
- 2 The reference sound pressure p_o is 20 microPascals (μPa).

3.5 Background A-weighted sound pressure level ($L_{A90,T}$)

The sound pressure level, obtained by using time-weighting 'F', which is equal to or exceeded for 90% of the time interval considered in the absence of the noise under investigation.

NOTE: For the definition of time-weighting 'F', refer to AS IEC 61672.1.

3.6 C-weighted sound level (L_{pC})

The sound pressure, in decibels, as given by—

$$L_{pC} = 10 \log_{10} (p_C/p_o)^2 \quad \dots 3.6$$

NOTES:

- 1 For the definition of C-weighting, refer to AS IEC 61672.1.
- 2 Sound level parameters noted above may also be measured with the C-weighting where required or recommended by statutory authorities. This may occur especially for sources potentially containing significant energy in the low frequency range of 25 Hz to 125 Hz. For these measurements, the same parameters noted above may be used but with the C-weighting network applied in place of the A-weighted network.

3.7 Immission

The sound received at one location from a source or sources at other locations.

3.8 Land use

The existing use to which land is put, together with the zoning designated by a planning scheme.

3.9 Long-term average A-weighted background sound pressure level ($L_{A90,LT}$)

The arithmetic average of the A-weighted background sound pressure levels ($L_{A90,T}$), after discarding any atypical results.

NOTES:

- 1 One example of this is a long-term period average background sound level ($L_{A90,period,LT}$), where the period is either daytime, evening, or night-time.
- 2 Some regulatory authorities use $L_{A95,LT}$ for long-term average background sound pressure level.

3.10 Long-term time average A-weighted sound pressure level ($L_{Aeq,LT}$)

The average over the long-term time interval of the time average A-weighted sound pressure levels for a series of shorter reference time intervals contained within the long-term time interval (LT), as given by—

$$L_{Aeq,LT} = 10 \log_{10} \left[\frac{1}{N} \sum_{i=1}^N 10^{0.1 L_{Aeq,T_i}} \right] \quad \dots 3.10$$

where

N = number of reference time intervals

L_{Aeq,T_i} = time average A-weighted sound pressure level in the i th reference time interval

NOTE: In some cases, more than one long-term time average A-weighted sound pressure level will be of interest; for example, a long-term time average A-weighted sound pressure level obtained by averaging levels for the daytime reference time intervals and a long-term time average A-weighted sound pressure level obtained by averaging levels for the night-time reference time intervals.

3.11 Long-term average percent exceedance A-weighted sound pressure level ($L_{A\%,LT}$)

The arithmetic average over the long-term time interval of the percent exceedance levels for a series of reference time intervals, after discarding any atypical results.

3.12 Long-term time average rating sound level ($L_{Ar,LT}$)

The average over the long-term time interval (LT) of the rating sound levels for a series of reference time intervals where the time intervals are equal, as given by—

$$L_{Ar,LT} = 10 \log_{10} \left[\frac{1}{N} \sum_{i=1}^N 10^{0.1 L_{Ar,T_i}} \right] \quad \dots 3.12$$

where

L_{Ar,T_i} = rating level in the i th reference time interval

NOTE: In some cases more than one value of the long-term time average rating level will be of interest; for example, a value obtained by averaging the levels for daytime reference time intervals and another obtained by averaging those for night-time reference time intervals, over a period of several days, typically one week minimum.

3.13 Long-term time interval (LT)

A measurement time interval (a period of 4 h or longer) for which the results of the noise measurement are representative of the situation under investigation.

NOTE: The long-term time interval (LT) consists of a series of reference time intervals and is determined for the purpose of describing the environmental noise. It is generally designated by relevant authorities. It may also be related to a period of the 24-hour day, typically daytime, evening or night-time.

3.14 Noise zone

A region where the long-term time average rating level or long-term time average percent exceedance A-weighted sound pressure level lies between two specified levels (e.g. 65 dBA and 70 dBA).

3.15 Percent exceedance A-weighted sound pressure level ($L_{A\%,T}$)

The A-weighted sound pressure level obtained by using time-weighting 'F' that is equalled or exceeded for a percentage of the time interval considered (for example, $L_{A95,1h}$ is the A-weighted sound pressure level exceeded for 95% of 1 h).

NOTES:

- 1 For the definition of time-weighting 'F', refer to AS IEC 61672.1.
- 2 Percent exceedance sound pressure levels as determined over a certain time interval cannot generally be extrapolated to other time intervals.

3.16 Rating sound level ($L_{Ar,T}$)

The time average A-weighted sound pressure level of a sound source during a specified time interval, plus specified adjustments including noise character, as appropriate.

3.17 Reference time interval (T)

The time interval over which the parameter is measured.

NOTE: The reference time interval (T) may be specified in national or international Standards or by relevant authorities to cover typical human activities and variations in the operation of sound sources. Typical intervals range from 10 minutes to 1 hour.

3.18 Sound exposure level (L_{AE})

The instantaneous A-weighted sound pressure [$p_{A(t)}$], integrated over the specified time duration at the noise event and referenced to a duration of 1 s, as is given by—

$$L_{AE} = 10 \log_{10} \left[\frac{1}{t_o} \int_{t_1}^{t_2} \frac{p_{A(t)}^2}{p_o^2} dt \right] \quad \dots 3.18$$

where

$p_{A(t)}$ = instantaneous A-weighted sound pressure at time t

t_2, t_1 = start and finish times of stated time interval long enough to encompass all significant sound of a stated event

t_o = reference duration of 1 s

p_o = reference sound pressure equal to 20 microPascals (μ Pa)

NOTE: L_{AE} is also described in Paragraph A2.7(d), Appendix A. It is often used to compare pass-by measurements of transportation sources. For example, comparing the effect of different helicopter overflights.

3.19 Sound pressure level (L_p)

The level of the root-mean-square (r.m.s.) sound pressure in decibels, as given by—

$$L_p = 10 \log_{10} \left(\frac{p}{p_o} \right)^2 \quad \dots 3.19$$

where

p = the r.m.s. sound pressure in Pascals

p_o = the reference sound pressure equal to 20 microPascals (μ Pa)

3.20 Specific sound

A component of the ambient sound, which can be specifically identified by aural means and subsequently identified by acoustical means and which may be associated with a specific source.

3.21 Spectrum sound levels—Octave or one-third octave ($L_{p,Oct,T}$ or $L_{p,1/3rd Oct,T}$)

The sound pressure level measured within an octave band from 31.5 Hz to 8 kHz; or within a one-third octave band from 25 Hz to 10 kHz.

NOTES:

- 1 The frequency range may be wider than noted for specific purposes. The range given is typical for environmental noise assessment.
- 2 Spectrum sound levels may be measured for assessment of tonality or comparison of spectrum content. One-third octave spectral measurements may be required by statutory regulations or policy for assessment of tonality. These may be required using the A, C or Z weighting, statistical parameters will typically also apply for these measurements (time averaged $L_{Aeq,t,Oct,T}$ or percent exceedance sound levels such as $L_{pA90,1/3rd Oct,T}$).

3.22 Time average A-weighted sound pressure level ($L_{Aeq,T}$)

The value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval (T), has the same mean square sound pressure as a sound under consideration whose level varies with time, as given by—

$$L_{Aeq,T} = 10 \log_{10} \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \frac{p_{A(t)}^2}{p_o^2} dt \right] \quad \dots 3.22$$

where

$p_{A(t)}$ = instantaneous A-weighted sound pressure of the sound signal at time t

p_o = reference sound pressure equal to 20 microPascals (μPa)

t_2, t_1 = start and finish times of the measured time interval T (see Note 1)

NOTES:

- 1 The minimum recommended time period is 10 minutes. Regulatory authorities or policy documents may have different minimum time periods.
- 2 Time average A-weighted sound pressure level during time interval (T) is also called equivalent continuous A-weighted sound pressure level with the averaging time interval usually indicated in the format, (for example, 1-hour average A-weighted sound pressure level, $L_{Aeq,1h}$).
- 3 Equivalent continuous A-weighted sound pressure level is sometimes also used for assessment of occupational noise exposure (refer to the AS/NZS 1269 series).

4 SYMBOLS

The quantity symbols and unit symbols used in this Standard are listed in Table 1.

TABLE 1
SYMBOLS

Quantity	Quantity symbol	Unit symbol	Remarks
Sound pressure level	L_p	dB	
A-weighted sound pressure level	L_{pA}	dBA	
Percent exceedance A-weighted sound pressure level	$L_{A\%,T}$	dBA	Level exceeded for a percentage of time interval T
Sound exposure level	L_{AE}	dBA	For discrete noise events
Time average A-weighted sound pressure level	$L_{Aeq,T}$	dBA	Time interval shall be stated
Long-term time average A-weighted sound pressure level	$L_{Aeq,LT}$	dBA	Time interval shall be stated
Rating sound level	$L_{Ar,T}$	dBA	Time interval shall be stated
Long-term time average rating sound level	$L_{Ar,LT}$	dBA	Time interval shall be stated
Long-term average percent exceedance	$L_{A\%,LT}$	dBA	Time interval shall be stated
A-weighted sound pressure level	$L_{A90,LT}$	dBA	Time interval shall be stated
Background A-weighted sound pressure level	$L_{A90,T}$	dBA	Time interval shall be stated
Adjusted percent exceedance A-weighted sound pressure level	$L_{A\%,adj,T}$	dBA	Time interval shall be stated
Long-term average background A-weighted sound pressure level	$L_{A90,LT}$	dBA	Time interval shall be stated
C-weighted sound pressure level	L_{pC}	dB	Can be any parameter noted above for A-weighting
Octave band spectrum sound level	$L_{p,Oct}$	dB	Can be weighted or percent exceedance or other parameter
One-third octave band spectrum sound level	$L_{p1/3rd Oct}$	dB	Can be weighted or percent exceedance or other parameter
A-weighted tonally adjusted sound pressure level	$L_{AT,adj}$	dB	Time interval shall be stated

5 INSTRUMENTATION

5.1 General

Sound level meters shall be Class 1 or Class 2, as specified in AS IEC 61672.1. Where used, statistical analysers and data loggers shall provide equivalent performance, in respect of frequency-weighting, time-weighting, statistical accuracy and in tolerances, to the instrumentation specified in Table 1. Storage devices, including but not limited to level recorders, magnetic tape recorders and digital recorders, shall also conform with the relevant requirements of AS IEC 61672.1.

NOTES:

- 1 Special care should be taken to ensure that the dynamic range of the instruments is large enough for the applications, and that the inherent electrical noise and overload capacity of these instruments are suitable.

- 2 The frequency range of the instruments used should also be considered. Typically the range of frequencies should include, as a minimum, the one-third octave bands from 25 Hz to 10 000 Hz. For measurements of low-frequency sound to this Standard, the frequency range should include the one-third octave bands from 12.5 Hz to 10 000 Hz. Other frequency ranges may be required by specific Standards or regulatory policy documents.
- 3 The accuracy of the measurement will depend on the temporal characteristics of the sound being measured and the type of instrumentation being used. Care should be taken to achieve required accuracy in any given circumstances.
- 4 Methods of determining the time average A-weighted sound pressure level using the various kinds of equipment are given in Clause 6.4.

5.2 Measurement of time average A-weighted sound pressure level ($L_{Aeq,T}$)

The instrumentation to measure $L_{Aeq,T}$ shall include but is not limited to—

- (a) integrating-averaging sound level meter set to frequency-weighting 'A'; or
- (b) data analyser for sampling the running value of A-weighted sound pressure level.

5.3 Measurement of percent exceedance A-weighted sound pressure level ($L_{A\%,T}$)

The instrumentation to measure $L_{A\%,T}$ shall include but is not limited to—

- (a) sound level meter set to frequency-weighting 'A' and time-weighting 'F' with built-in capability for measuring this descriptor; or
- (b) data analyser for sampling the running value of A-weighted sound pressure level.

5.4 Measurement of sound exposure level (L_{AE})

The instrumentation to measure L_{AE} shall include but is not limited to—

- (a) integrating-averaging sound level meter set to frequency-weighting 'A'; or
- (b) data analyser for sampling the running value of A-weighted sound pressure level.

5.5 Calibration

The complete measuring system, including portable reference sound sources and any sound recording instruments, shall be calibrated over their full frequency and dynamic range and the configuration for calibration shall be in accordance with AS IEC 61672.1 or IEC 60942, as appropriate. A comprehensive recalibration shall be carried out at intervals not exceeding two years.

5.6 Field checks of calibration

The performance of the instrumentation when in field use shall be checked periodically with a pistonphone, portable reference sound source or other portable checking device appropriate to the sound level meter or other instrumentation system, and immediately before and after measurements are made. For remote logging stations some form of calibration shall be performed at regular intervals. This could be by electronic or acoustic means. For extended measurement periods, these checks shall be performed immediately before and after each measurement sequence. Where the calibration signal cannot be excluded from the data, the instrument shall not be switched off between checks. In all cases, the operating instructions for the instrument shall be followed carefully. If the instrumentation system registers a discrepancy equal to or greater than 1 dB between consecutive checks, any measurements in the interval between the two checks shall be considered invalid.

6 MEASUREMENTS

6.1 General

Details of the measurement instrumentation, measurement procedure, and conditions prevailing during the measurements shall be recorded and kept for reference purposes.

Reference to the relevant Standards shall also be included in the report of the measurements.

NOTE: In some circumstances, the frequency-weighting network 'A' is inadequate for filtering out high-level infrasound, which occurs near some industrial locations, wind farms, surf beaches and some forms of transport, as well as occurring near buildings owing to wind turbulence. This may cause overload and, if not detected, the resulting distortion produced at higher frequencies may be inaccurately attributed to audible sound.

6.2 Measurement positions

6.2.1 General

The choice of the actual measurement positions depends on the purpose of the measurements, as specified in other parts of this Standard, or in other applicable Standards or as specified by the relevant regulatory authority.

The microphone shall be oriented so that it is most uniformly sensitive to the incident sound of the subject source (if there is one).

6.2.2 Outdoor measurements

Where it is desired to minimize the influence of reflections, outdoor measurements shall, whenever possible, be carried out at least 3.5 m from any reflecting structure other than the ground. The preferred measurement height is 1.2 m to 1.5 m above the ground.

6.2.3 Outdoor measurements near buildings

Outdoor measurements near a building shall be carried out at places where the noise to which the building is exposed is of interest. Except when determining $L_{A90,T}$, an adjustment may be necessary where an approximation of the free field incident level is required. See Note 3.

NOTES:

- 1 The measurement positions should be 1 m from the facade and 1.2 m to 1.5 m above each floor level of interest. An adjustment may be necessary where an approximation of the free field incident level is required to account for the influence of facade reflections (see Note 2). Where measurements are made at different levels of a multi-storey building such as an apartment block, the location should be 1 m from the facade of the building separating the external area from the interior area.
- 2 Where measurements are made near a building the importance of certain transmission paths (for example, transmission through open or closed doors and windows) should be considered.
- 3 If measurements are performed 1 m from the facade of a building and the sound is directly incident on that facade, an approximation of the free-field incident level may be obtained by subtracting 2.5 dB from the measured value. To characterize the effects of the walls of a building to be erected, the addition of 2.5 dB to the free-field values may be useful in order to estimate the sound pressure level near the walls. If measurements are made in the plane of the facade, subtracting 6 dB from the measured value to approximate the free-field sound level.
- 4 Measurements may be performed in the plane of a facade or roof of a structure utilizing a microphone whose protection grid or diaphragm is flush with the surface. Alternative techniques using pressure zone microphones placed against the relevant surface may be used.

6.2.4 Measurements inside buildings

Measurements inside buildings shall be carried out in those locations at which the noise is of interest.

NOTES:

- 1 The measurement positions should be at least 1 m from the walls or other major reflecting surfaces, 1.2 m to 1.5 m above the floor, and about 1.5 m from windows. For general measurements within a room, at least three discrete locations should be used, evenly distributed in areas of the room where the sound level is required, unless the separation distance is less than 1 m.

- 2 Where measurements are made inside buildings, the importance of certain transmission paths (for example, transmission through open or closed doors and windows) should be considered as well as location of room modes at low frequencies, when determining microphone positions.
- 3 The presence of furnishings or other reflective or absorptive surfaces, which may result in shielding or scattering of the noise, should also be considered.
- 4 Attention is drawn to the possibility of instrument overload due to strong low frequency components inside buildings.

6.3 Meteorological conditions

6.3.1 General

For outdoor measurements, changes in meteorological conditions may influence the received sound level from distant noise sources. In such cases for long-term measurements, meteorological conditions occurring over the measurement period shall be recorded. For short-term or single interval measurements the meteorological conditions occurring over the interval shall be recorded.

Wind speed shall be measured at locations representative of the meteorological conditions of the area at the time of measurement and at the microphone location. The effect of wind noise on the microphone shall be at least 10 dB below the received sound level at the time of measurement or shall be assessed to confirm that it does not adversely affect the measurement. The microphone shall be fitted with a windscreen of known performance during all outdoor measurements.

NOTES:

- 1 Where the maximum wind speed exceeds 5 m/s at the measurement position and noise measurements are required, caution should be applied and special windscreens should be utilized, if available. The performance of these windscreens should be assessed to determine conformance with the requirements of this Standard or the applicable correction data that the effect of wind noise on the microphone is at least 10 dB below the measured sound level to be applied. The wind speed measurement point should be as close as practicable to the planned position of the microphone.
- 2 Where meteorological instrumentation is not available wind speeds should be assessed using the Beaufort wind scale (see Appendix C). Alternatively, if justified, data from the nearest relevant meteorological station may be appropriate.
- 3 Rainfall can significantly affect measured sound levels through the effect of rain noise on the surrounding area and microphone, waterlogging of the windscreen and increased source sound levels from sources such as road traffic. For this reason, it is considered that data measured during periods of rain should be discarded from a data-set, unless it can be shown that the effect has been negligible or if the measurement location was protected from rain and intended to measure sound levels during rain periods. After the rain has stopped, the acoustic properties of the windscreen may be modified. For standard windscreens of 90 mm diameter, this effect can be significant for frequencies higher than 1 kHz if the amount of precipitation is greater than 1 mm and can remain significant for a duration necessary for the windscreen to dry out. Some formulae exist to calculate drying time but they do not allow for local wind speed, temperature, relative humidity or other factors in the drying period and should be considered with caution.
- 4 The wind/meteorological station should not affect the sound levels being measured.

6.3.2 Levels to be averaged over all relevant weather conditions

The long-term time average rating level ($L_{A,T}$) shall be calculated from the individual results, representing all relevant weather conditions.

NOTE: An advantage of this scheme is that typical variations in emission level of the source are taken into account in the most realistic way, that is, as they occur.

6.3.3 Levels to be determined under specified weather conditions

Where the measurement requirements refer to receiver sound levels under specified meteorological conditions, the meteorological conditions when the measurements are taken shall be specified. Where appropriate, the conditions specified shall be those for which the sound pressure levels at the receiver positions are the highest.

NOTES:

- 1 The highest received sound pressure level will usually occur when the wind direction has a small angle; for example, less than 45° to the direction of propagation from the source to the receiver.
- 2 Where the source of noise under investigation is more than 100 m from the measurement position, temperature gradients including inversions and wind gradients may substantially affect the received sound pressure levels.
- 3 Variation of the emission levels of the source may be a problem as certain conditions of the operation of the source may not occur under the specified weather conditions.

6.3.4 Meteorological instrumentation

Where meteorological measurements are made for conditions at the measurement location, the meteorological instruments shall conform with the following requirements:

- (a) *Temperature* The atmospheric temperature shall be measured using an instrument with an accuracy of $\pm 1^\circ\text{C}$.

NOTE: This specification can be satisfied by a bulb thermometer, digital thermometer or a thermograph.

- (b) *Relative humidity* The relative humidity shall be measured using an instrument with an accuracy of $\pm 5\%$.

NOTE: A good quality psychrometer of the whirling or self-ventilating type is deemed to conform to this requirement.

- (c) *Barometric pressure* The barometric pressure shall be measured using an instrument with an accuracy of ± 3 kPa.

NOTE: A calibrated aneroid barometer is deemed to conform to this requirement.

- (d) *Wind speed and direction* The measurement of wind speed and direction shall be at the microphone location for the sound level measurements using an instrument with a wind speed accuracy of $\pm 20\%$ and a wind direction resolution of $\pm 20^\circ$. The height above the ground at which the measurements are taken shall be recorded.

NOTE: Some cup anemometers with a direction vane and some propeller anemometers with a direction vane are deemed to conform to these requirements.

- (e) *Rainfall* The measurement of rainfall shall be at the location for the sound level measurements using an instrument with an accuracy of 0.1 mm over each measurement interval (for example, sample interval of 15 minutes).

NOTE: Most electronic tipping bucket rain-gauges have an accuracy of 0.05 mm.

6.4 Measurement procedure—Selection of measurement interval

The measurements shall be obtained at the relevant time and place of interest for the subject of the study. If a comparison is being made between a source operating and not operating, the same or similar locations and times of day shall be used for the measurements to ensure that comparisons are like-for-like (see Notes 1 and 2).

Different regulatory regimes may have different minimum periods for measurement, (for example, 15 minutes or 30 minutes). Where applicable, the specified minimum periods shall be used (see Note 3).

For long-term measurements, as many important or relevant emission or propagation conditions as possible shall be included within the window of time available for the measurements. Source operating conditions (for example, traffic composition and vehicle flow conditions) shall be as representative as possible to minimize later corrections (see Note 4).

For short-term measurements, the selected measurement time interval shall include all significant variations in noise emission from the subject source (see Note 5).

If the noise is from a single event, such as an aircraft flyover in which the sound level varies during the event and is absent during a considerable time interval, then the measurement time interval should be chosen to be of a comparable duration to the single event time interval (see Note 6).

NOTES:

- 1 Typically, a measurement of environmental noise will be made at a receiver location subject to emissions from a source, such as industry, transport or other sources. Measurements should be taken to obtain a representative sample of the source operation and of the background without the source operation.
- 2 The recommended minimum averaging time or measurement interval is 10 minutes. Extended measurement periods should be subdivided into individual time intervals of not more than 1 hour.
- 3 Typically, a minimum period of 10 minutes is considered suitable for normal variations in environmental sound level and also matches the sample period of many meteorology recording station data provided by the Bureau of Meteorology.
- 4 If propagation conditions vary strongly between the different seasons of the year, it might be necessary to measure during several different seasons to achieve a low measurement uncertainty.
- 5 If the source emission displays periodicity, the measurement time interval should preferably cover an integer number of several periods or cycles of operation. If continuous measurements over such a period cannot be made, measurement time intervals may be chosen so that each represents a part of the cycle and so that together they represent a complete cycle.
- 6 The basic approach is to measure the sound levels and record the maximum, minimum, L_{AE} and $L_{Aeq,T}$ sound levels for the measurement interval. Other statistical parameters may also be relevant for different types of measurements or required by different regulatory documents.

6.5 Procedures for the determination of time average A-weighted sound pressure level ($L_{Aeq,T}$)

6.5.1 General

The environmental noise descriptors defined in this Standard may be used for a variety of purposes. Procedures for certain specific sound sources are described in other relevant Australian Standards or are specified by the relevant regulatory authority.

6.5.2 Steady sound

If the sound is steady over the period of interest, the measurements shall be carried out with the frequency-weighting network 'A' and the time-weighting 'F' shall be used. The range of sound levels measured (maximum, minimum and events) and $L_{Aeq,T}$ shall be recorded.

NOTE: Typically, variations less than or equal to $\pm 3\text{dBA}$ are considered steady. It may also be helpful or relevant to record the $L_{A90,T}$.

6.5.3 Non-steady sound

For fluctuating, impulsive or other non-steady sound, the measurements shall be carried out with instrumentation in accordance with Clause 5.1. The percent exceedance sound levels (typically $L_{A01,T}$, $L_{A10,T}$, $L_{A90,T}$ and others as required) shall be measured and presented in a statistical format and the range of sound levels measured (maximum, minimum and events) and $L_{Aeq,T}$ shall be recorded.

6.5.4 Steady sound with stepped variations of level

If the sound is steady (see Clause 6.5.2) but occurs at a number of clearly distinguishable values of sound pressure levels, the separate levels may be measured as for steady noise and the durations associated with each level determined, thus permitting the calculation of the time average A-weighted sound pressure level (if required) from the following equation or from direct measurements of a number of cycles:

$$L_{Aeq,T} = 10 \log_{10} \frac{1}{T} \sum_{i=1}^n T_i 10^{0.1 L_{pAi}} \quad \dots 6.5.4$$

where

T = total time interval

L_{pAi} = A-weighted sound pressure level prevailing during the time interval (T_i)

NOTES:

- 1 For a diagrammatic representation of steady sound with stepped variations of level, see Figure B1, Appendix B.
- 2 The separate levels and their durations should be recorded.
- 3 Where possible, at least three full cycles of variations in level should be recorded, if possible.

6.5.5 Separate sound events

Where a noise environment is the result of a number of identifiable noise events, the time average A-weighted sound pressure level may be calculated from the time averaged A-weighted sound pressure level of the individual events occurring within a time period (T) from the following equation or by direct measurement from the sound level meter:

$$L_{Aeq,T} = 10 \log_{10} \frac{1}{T} \sum_{i=1}^n T_i 10^{0.1 L_{Aeq,Ti}} \quad \dots 6.5.5$$

where

$L_{Aeq,Ti}$ = time averaged A-weighted sound pressure level of the i th event in a series of n events in the time period (T), in seconds

The maximum, minimum, percent exceedance sound levels (typically $L_{A01,T}$, $L_{A10,T}$, $L_{A90,T}$ and others as required) and $L_{Aeq,T}$ shall be recorded.

6.6 Determination of rating level

6.6.1 General

The measurements described in this Standard are designed to give a reliable physical description of the environmental noise. For assessment of human reactions to a subject noise, it is sometimes necessary to make adjustments to the measured values in order to arrive at a more meaningful basis for the assessment. This may also be required by regulatory authorities when the noise includes potentially annoying characteristics such as tonality, impulsiveness or intermittency. Where such adjustments are made to a value of time average A-weighted sound pressure level, it is termed rating sound level ($L_{A,T}$).

Adjustments in total shall not exceed 10 dBA.

Statutory authorities may have different approaches to addition and capping of adjustments and their documents should be referred to when relevant.

6.6.2 Determination of rating level

The rating level shall be determined over the measurement time intervals related to the characteristics of the source(s) and receiver(s) and long enough to cover at least one typical cycle of variation, if any.