

BS 4142:2014+A1:2019



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Methods for rating and assessing industrial and commercial sound

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 October 2014. It was prepared by Sub-committee EH/1/3, *Residential and industrial noise*, under the authority of Technical Committee EH/1, *Acoustics*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

BS 4142:2014 superseded [BS 4142:1997](#), which has been withdrawn.

BS 4142:2014+A1:2019 supersedes BS 4142:2014, which is withdrawn

Information about this document

BS 4142 was first published in 1967, and was revised in 1990 to align it with elements of ISO 1996. The 1997 edition clarified aspects of the standard in the light of comments from users.

This edition has been prepared under the direction of the Health and Environment Sector Board. The general basis for the standard is derived from the application of previous editions, together with accumulated experience. Some aspects, including guidance on character corrections, are based upon research which has been reported since publication of the previous edition of this standard.

This edition clarifies the application of the standard. New to this edition is the introduction of uncertainty, including good practice for reducing uncertainty. The examples in [Annex A](#) have been considerably expanded.

Response to sound can be subjective and is affected by many factors, both acoustic and non-acoustic. The significance of its impact, for example, can depend on such factors as the margin by which a sound exceeds the background sound level, its absolute level, time of day and change in the acoustic environment, as well as local attitudes to the source of the sound and the character of the neighbourhood. This edition of the standard recognizes the importance of the context in which a sound occurs. Great care has, therefore, been taken in the use of the words “sound” and “noise”. Sound can be measured by a sound level meter or other measuring system. Noise is related to a human response and is routinely described as unwanted sound, or sound that is considered undesirable or disruptive.

Text introduced or altered by Amendment No. 1 is indicated in the text by tags A1 A1. Minor editorial changes are not tagged.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard is presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material are presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

1.1 This British Standard describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- a) sound from industrial and manufacturing processes;
- b) sound from fixed installations which comprise mechanical and electrical plant and equipment;
- c) sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- d) sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from fork-lift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

1.2 This standard is applicable to the determination of the following levels at outdoor locations:

- a) rating levels for sources of sound of an industrial and/or commercial nature; and
 - b) ambient, background and residual sound levels,
- for the purposes of:
- 1) investigating complaints;
 - 2) assessing sound from $\boxed{A_1}$ existing, $\boxed{A_1}$ proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and
 - 3) assessing sound at proposed new dwellings or premises used for residential purposes.

1.3 The determination of noise amounting to a nuisance is beyond the scope of this British Standard.

Sound of an industrial and/or commercial nature does not include sound from the passage of vehicles on public roads and railway systems.

The standard is not intended to be applied to the rating and assessment of sound from:

- a) recreational activities, including all forms of motorsport;
- b) music and other entertainment;
- c) shooting grounds;
- d) construction and demolition;
- e) domestic animals;
- f) people;
- g) public address systems for speech; and
- h) other sources falling within the scopes of other standards or guidance.

$\boxed{A_1}$ The methodology set out in [Clauses 7, 8, and 9](#) of this standard is not intended to be used to assess the extent of the impact at indoor locations. Internal sound levels can be taken into account as outlined in [Clause 11](#). $\boxed{A_1}$

$\boxed{A_1}$ The standard is not intended to be applied to the assessment of indoor sound levels. $\boxed{A_1}$

The standard is not applicable to the assessment of low frequency noise.

NOTE Information on the assessment of low frequency noise is given in NANR45 [1, 2].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 60942, *Electroacoustics — Sound calibrators*

BS EN 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

BS EN 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

NOTE All the measurements and values used throughout this standard are "A"-weighted. Where "A" weighting is not explicit in the descriptor, it is to be assumed in all cases, except where it is clearly stated that it is not applicable, as in the case of tones.

3.1 acoustic environment

sound from all sound sources as modified by the environment

[SOURCE: BS ISO 12913-1:2014, 3.4]

3.2 ambient sound

totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far

NOTE The ambient sound comprises the residual sound and the specific sound when present.

3.3 ambient sound level, $L_a = L_{Aeq,T}$

equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a given time interval, T

NOTE The ambient sound level is a measure of the residual sound and the specific sound when present.

3.4 background sound level, $L_{A90,T}$

A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T , measured using time weighting, F , and quoted to the nearest whole number of decibels

3.5 equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$

value of the A-weighted sound pressure level in decibels of continuous steady sound that, within a specified time interval, $T = t_2 - t_1$, has the same mean-squared sound pressure as a sound that varies with time, and is given by the following equation:

$$L_{Aeq,T} = 10 \lg_{10} \left[(1/T) \int_{t_1}^{t_2} (p_A(t)^2 / p_0^2) dt \right] \quad (1)$$

where:

p_0 is the reference sound pressure (20 μPa); and

$p_A(t)$ is the instantaneous A-weighted sound pressure (Pa) at time t

NOTE The equivalent continuous A-weighted sound pressure level is quoted to the nearest whole number of decibels.

3.6 measurement time interval, T_m

total time over which measurements are taken

NOTE This may consist of the sum of a number of non-contiguous, short-term measurement time intervals.

3.7 rating level, L_{A_r, T_r}

specific sound level plus any adjustment for the characteristic features of the sound

3.8 reference time interval, T_r

specified interval over which the specific sound level is determined

NOTE This is 1 h during the day from 07:00 h to 23:00 h and a shorter period of 15 min at night from 23:00 h to 07:00 h.

3.9 residual sound

ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound

3.10 residual sound level, $L_r = L_{Aeq, T}$

equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T

3.11 specific sound level, $L_s = L_{Aeq, T_r}$

equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r

3.12 specific sound source

sound source being assessed

4 Preparation

The assessor should gain a sufficient understanding of the situation (context) to be rated and assessed by conducting an appraisal, as appropriate, in order to:

- identify and understand all the sounds that can be heard, and identify their sources;
- identify which measurement methods, instruments and metrics (see [Clause 5](#)) would be most appropriate for the assessment;
- identify potential measurement locations;
- identify the necessary measurement frequencies, durations and timings; and
- where a new development is to be assessed, understand what kind of sound a new industrial $\langle A_1 \rangle$ and/or commercial $\langle A_1 \rangle$ source would introduce, or what potential impact would be imposed from an existing source on a new sensitive receptor.

5 Instrumentation

5.1 General

Select systems for measuring sound pressure levels, including microphone(s), cable(s), windscreen(s), recording devices and other accessories which conform to BS EN 61672-1, Class 1, for free-field application, as appropriate. Filters, where used, should conform to BS EN 61260, Class 1, and sound calibrators to BS EN 60942, Class 1.

 Text deleted 

5.2 Verification

Demonstrate conformity of the measuring system, filters where appropriate and the sound calibrators with the requirements of 5.1 by means of valid certificates showing conformity to each relevant standard following testing according to the appropriate part of that standard.

NOTE 1 It is recommended that sound calibrators are calibrated at intervals not exceeding 1 year, conformity of the measuring systems with BS EN 61672-1 is verified at intervals not exceeding 2 years, and the conformity of filters with BS EN 61260 is verified at intervals not exceeding 2 years.

NOTE 2  It is also acceptable to verify measuring systems in accordance with [BS 7580-1](#). 

6 Measurement procedure

6.1 Field calibration check

At the beginning of every measurement session check the calibration of the measuring system at one or more frequencies in accordance with the manufacturer's instructions, by means of a sound calibrator and check the calibration value at the end of the measurement. Where the difference between the initial calibration value, any subsequent calibration check, and a final calibration check on completion of measurements exceeds 0.5 dB, treat with caution the results of measurements obtained for any period to which this relates.

NOTE The level of acceptable calibration drift needs to be considered in the context of the entire measurement period. A calibration drift exceeding 0.5 dB might be considered acceptable for an unattended measurement system that has been deployed for several days between calibration checks. In this case, the drift should be reported. Where the drift is 1 dB or more, the measurement chain should be thoroughly investigated to determine the source of the drift. If a fault in the sound measuring system has been identified, then the veracity of the data should be treated with extreme caution.

6.2 Measurement locations

Choose outdoor measurement locations that will give results that are representative of the ambient sound and residual sound at the assessment location(s). Make the measurement of the ambient sound level, the residual sound level and the background sound level at a height of 1.2 m to 1.5 m above the ground, unless there is a specific reason to use an alternative height (which should be justified), and under similar conditions, e.g. similar influence of reflections and measurement height above the ground. Where practical, minimize the influence of reflections by making the measurements at least 3.5 m from any reflecting surface other than the ground.

Where it is necessary to undertake measurements above ground floor level, choose a location which is approximately 1 m from the facade on the relevant floor of the building if it is not practical to make the measurements at least 3.5 m from the facade at this elevation.

NOTE When measurements for distant sources are made at 1 m from a facade, then the measured level can be adjusted to an equivalent free-field level by subtracting a 3 dB correction factor. For sources that are relatively close or not perpendicular to the facade the correction may be 1 dB or 2 dB, in which case the reasons for not using a correction of 3 dB should be explained.

Record the measurement location, height and the distance from any reflecting structure other than the ground.

6.3 Precautions against interference

Take precautions to minimize the influence on the measurements from sources of interference such as:

- a) wind passing over the diaphragm of the microphone of a sound measuring system, which can generate interference (see [6.4](#));
- b) rain falling on the microphone windshield or nearby surfaces, which can cause interference (see [6.4](#), [Clause 10](#) and [Annex B](#));
- c) electrical and electromagnetic interference, which can be caused in the sound measuring system by, for example, nearby power cables or radio transmitters; and
- d) temperature (see [6.4](#)).

An effective windshield should be used to minimize turbulence at the microphone.

NOTE Windshields are generally effective up to windspeeds of $\boxed{A_1}$ 5 m/s $\boxed{A_1}$.

6.4 Weather conditions

Record the weather conditions that could affect measurements. Monitor wind speed at the measurement location, using an anemometer, and record the wind speed together with the wind direction. Exercise caution when making measurements in poor weather conditions such as wind speeds greater than $\boxed{A_1}$ 5 m/s $\boxed{A_1}$.

Visually estimate cloud cover by eye as either a percentage of sky covered by cloud or in oktas. Record all forms of precipitation together with the period over which the precipitation occurred, having regard to how this might affect uncertainty (see [Clause 10](#) and [Annex B](#)).

Record the temperature at the measurement location, in °C, at the beginning and the end of the measurement period, and at any other appropriate time if there is a change in the weather conditions.

Where appropriate, use instruments for measuring meteorological parameters during long-term unattended measurements by means of a logging meteorological station at the measurement location.

NOTE 1 Weather conditions can affect sound levels by influencing sound propagation or generating sound which can be pertinent to the assessment.

NOTE 2 Whilst regional weather forecasts are useful in planning when to measure, local conditions can often vary significantly from the regional forecast. Forecasts should not be used instead of site measurements of the actual weather during the survey.

NOTE 3 It might be appropriate to make more than one assessment to account for varying weather conditions.

7 Specific sound level

7.1 General

Determine the specific sound level at the assessment location(s) as a discrete entity, distinct and free of other influences contributing to the ambient sound, in accordance with [7.3](#). Report in detail the methods used.

Ensure that all sample measurements are representative of the period of interest.

7.2 Reference time interval

Evaluate the specific sound over an appropriate reference time interval, T_r :

- a) 1 h during the day; and
- b) 15 min during the night.

NOTE 1 For the purposes of this standard, daytime is typically between 07:00 h and 23:00 h and accordingly night-time is between 23:00 h and 07:00 h.

NOTE 2 The shorter reference time interval at night means that short duration sounds with an on time of less than 1 h can lead to a greater specific sound level when determined over the reference time interval during the night than when determined during the day.

7.3 Determination of the specific sound level

NOTE Any rounding is to be done on the basis that a value of 0.5 is rounded up.

- 7.3.1** Measure the ambient sound level, distinguishing the specific sound from the residual sound. Minimize the influence of sound from other sources by measuring at times and during intervals when the residual sound has subsided to typically low levels.

Where the residual sound level fluctuates by an amount that materially affects the calculated specific sound level, report this.

NOTE The effects could potentially be minimized by measuring at a number of locations and/or periods, or by measuring close to the source and calculating the level at the assessment location(s).

- 7.3.2** Measure the residual sound level in the absence of the specific sound.
- 7.3.3** Correct for the effect of the residual sound by using the following formula:

$$L_s = 10 \lg(10^{L_a/10} - 10^{L_r/10}) \quad (2)$$

where:

L_s is the specific sound level;

L_a is the ambient sound level; and

L_r is the residual sound level.

NOTE 1 When measuring the residual sound level, all other conditions should be similar to the conditions that exist when the ambient sound level measurements are taken with the specific sound present.

NOTE 2 Where the variability in the residual sound level may be of significance the effect of such uncertainty should be considered as part of the assessment.

If the difference between the ambient sound level and the residual sound level is ≤ 3 dB, then see [7.3.6](#) and [7.3.7](#).

NOTE 3 This can be applicable where there is a greater difference if the residual or specific sound levels have a high degree of variability (see [7.3.13](#) and [7.3.15](#)).

- 7.3.4** Where possible, determine the specific sound level by measurement of the ambient sound level and the residual sound level at the assessment location(s).

NOTE It might be appropriate to take measurements if there are periods of low residual sound (such as at night or at weekends) when the specific sound would not normally occur but might be turned on for measurement purposes. The specific sound should as far as is practicable be representative of typical operating conditions.

- 7.3.5** Where it is not possible to determine the specific sound level by measurement of the ambient sound level and the residual sound level at the assessment location(s), for example, because the difference

between the ambient sound level and the residual sound level is ≤ 3 dB, determine the specific sound level by a combination of measurement and calculation. Report the method of calculation in detail and give the reason for using it.

NOTE In some cases, measurements can be supplemented by calculations. Calculations are often more reliable than a single short-term measurement when long-term averages are to be determined and in other cases where it is impossible to carry out measurements because of high residual sound levels. In case of the latter, it is sometimes convenient to carry out the measurements closer to the source and then use a calculation method to estimate the specific sound level at the assessment location(s).

- 7.3.6** Determine the specific sound level by calculation alone if measurement is not practicable, for example if the source is not yet in operation. In such cases, report the method of calculation in detail and give the reason for using it.

NOTE 1 When calculating rather than measuring sound pressure levels, it is necessary to have appropriate representative data on source sound emission, for example as a source sound power level (including source directivity), and the position of any point source(s) creating the same sound pressure levels in the environment as the real source. Often, such data are given in established calculation models but in other cases it is necessary that they be determined in each individual case.

NOTE 2 Using a suitable method for the sound propagation from source to receiver, the sound pressure level at the assessment point can be calculated. It is necessary to relate the sound propagation to well-defined meteorological and ground conditions. Most calculation models refer to neutral or favourable sound propagation conditions, as other propagation conditions are much more difficult to predict. The acoustic impedance of the ground is also important, in particular at large distances and low source and receiver heights.

- 7.3.7** Determine the specific sound level as separate component parts when:

- the influence of other sound sources can be avoided only by measuring samples of the specific sound; or
- the specific sound is composed of contributions from several sources which have been measured separately and, if necessary, corrected for propagation effects.

- 7.3.8** Determine the equivalent continuous A-weighted sound pressure level of the specific sound, $L_{Aeq,T}$ over time interval, T , from the equivalent continuous A-weighted sound pressure levels of its components L_{Aeq,T_i} according to equation (3).

$$L_{Aeq,T} = 10 \lg_{10} \left[(1/T) \sum T_i 10^{0.1 L_{Aeq,T_i}} \right] \quad (3)$$

where:

$T = \sum T_i$ if components are sequential; and

$T = \text{maximum value of } T_i$ if components are concurrent.

NOTE 1 The time interval, T , may contain intervals, T_i , during which the specific sound is off and the specific sound level is therefore nil.

Ensure that the measurement time intervals are long enough to obtain representative values of the equivalent continuous A-weighted sound pressure level.

NOTE 2 The separate components may be sequential, such as when measuring during troughs in the residual sound, or concurrent, such as when measurements are made close to separate sub-sources which normally operate concurrently and combine to produce a composite sound further away.

- 7.3.9** Determine the specific sound level over a time interval which reflects all significant temporal and level variations of the specific sound.

NOTE If the sound is steady, a short sample measurement is sufficient. If it is cyclic or intermittent or varies randomly, a longer sample is required to characterize it. It might be necessary to investigate the sound over relatively long periods to select an appropriate, representative measurement time interval.

- 7.3.10** If the measurement time interval, T_m , is equal to the reference time interval, T_r (see 7.2), measure the equivalent continuous A-weighted sound pressure level, $L_{Aeq,Tm}$, take this value to be L_a , correct for the influence of residual sound according to equation (2), and assign the result to the specific sound level.
- 7.3.11** If the specific sound is continuous, such that measurements over the time interval $T_m (< T_r)$ are representative of measurements over the reference time interval, T_r , measure the equivalent continuous A-weighted sound pressure level, $L_{Aeq,Tm}$, take this value to be L_a , correct for the influence of residual sound according to equation (2), and assign the result to the specific sound level.
- 7.3.12** If the specific sound fluctuates at random, select the measurement time interval, T_m , to give a reliable estimate of the equivalent continuous A-weighted sound pressure level over the reference time interval, T_r , measure the equivalent continuous A-weighted sound pressure level, $L_{Aeq,Tm}$, take this value to be L_a , correct for the influence of residual sound according to equation (2), and assign the result to the specific sound level.
- 7.3.13** If the specific sound is continuous and cyclic with a period less than or equal to the reference time interval, T_r , select the measurement time interval, T_m , to cover a whole number of complete cycles, measure the equivalent continuous A-weighted sound pressure level, $L_{Aeq,Tm}$, take this value to be L_a , correct for the influence of residual sound according to equation (2), and assign the result to the specific sound level (see Figure 1).

NOTE If continuous measurements over the measurement time interval, T_m , cannot be made, short-term measurement time intervals should be selected, so that each represents a part of a cycle and, together, they represent a complete cycle or number of cycles.

- 7.3.14** If the specific sound is intermittent and either steady or cyclic and the reference time interval, T_r , is over a representative time, and the on time is less than the reference time interval, determine the on time, T_o , and select the measurement time interval, $T_m \leq T_o$, to obtain a representative value for the equivalent continuous A-weighted sound pressure level $L_{Aeq,Tm}$ for the sound while it is on (see Figure 2). Take this value to be L_a and calculate the specific sound level as follows:

$$L_s = 10 \lg(10^{L_a/10} - 10^{L_T/10}) + 10 \lg(T_o / T_r) \quad (4)$$

Figure 1 — Selecting the measurement time interval

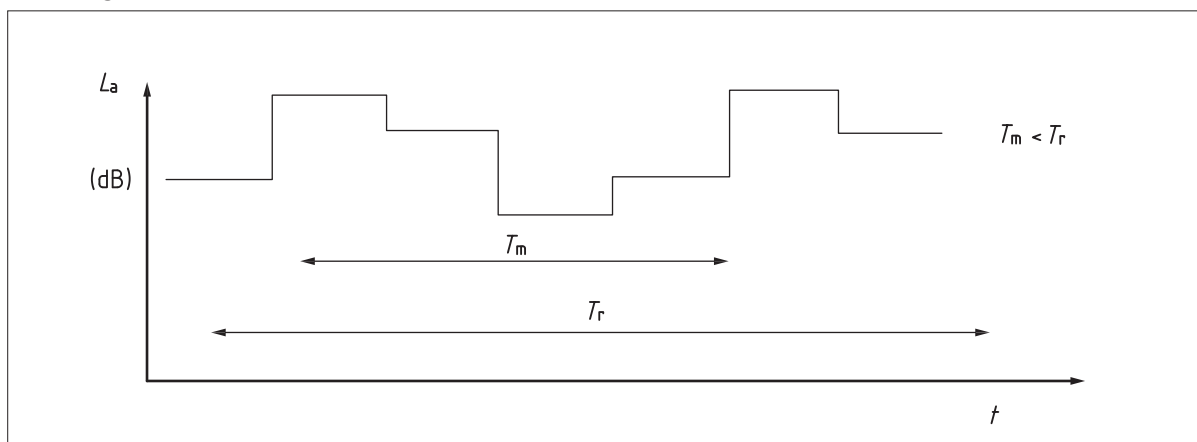
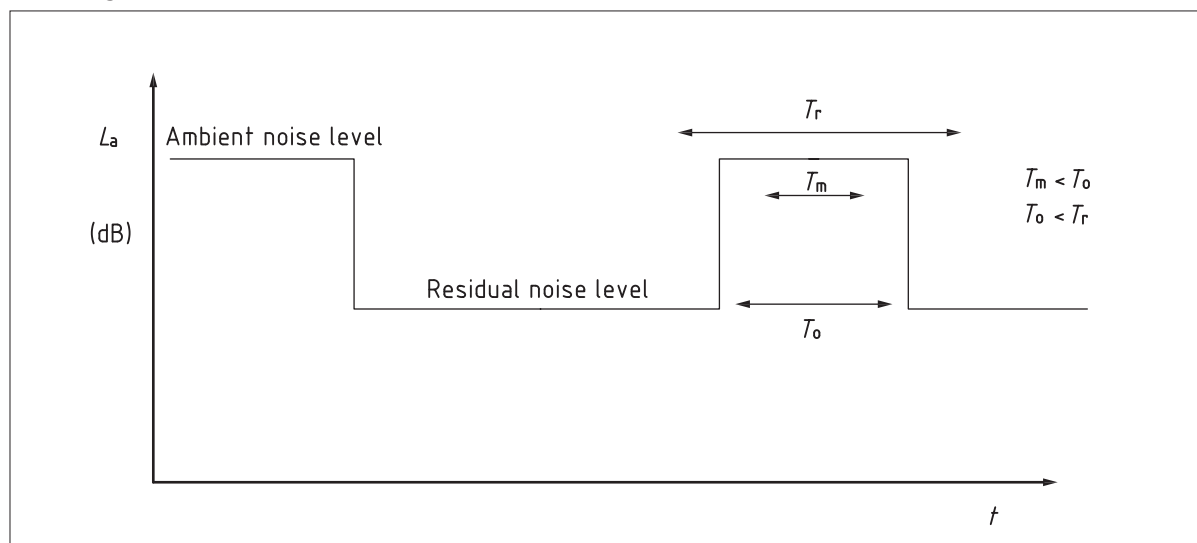
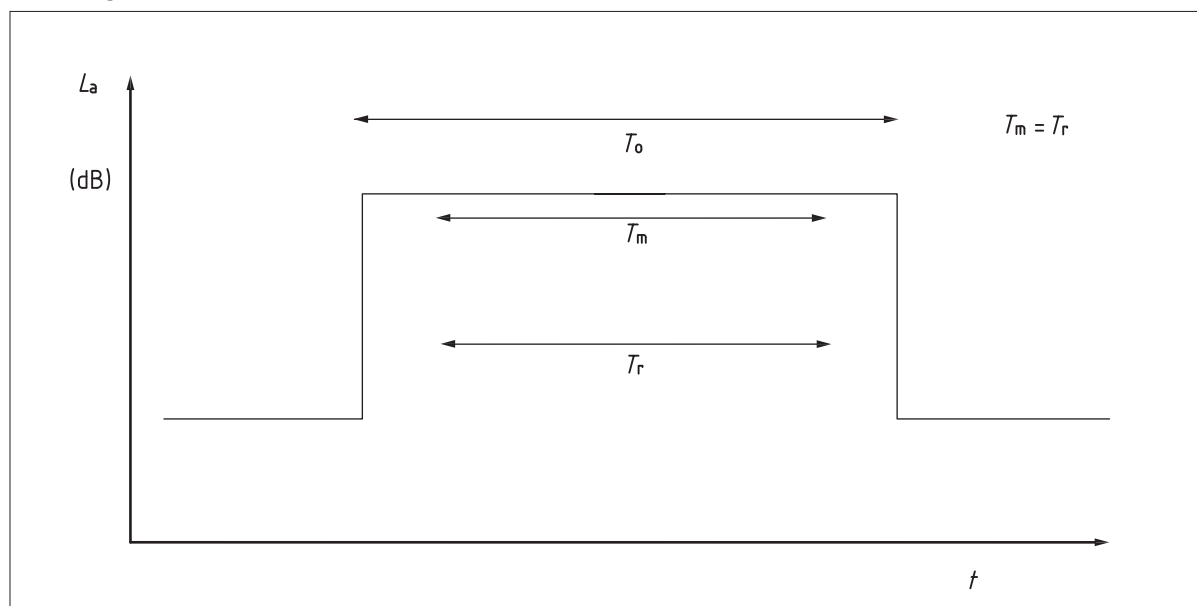


Figure 2 — Selecting the measurement time interval

- 7.3.15** If the specific sound is intermittent or cyclic, and the reference time interval is over a representative time, and the on time is equal to or greater than the reference time interval, select the measurement time interval, T_m , to obtain a representative value for the equivalent continuous A-weighted sound pressure level $L_{Aeq,Tm}$, and take this value to be L_a . Correct for the influence of residual sound according to equation (2), and assign the result to the specific sound level (see [Figure 3](#)).

Figure 3 — Selecting the measurement time interval

8 Background sound level

8.1 General

COMMENTARY ON 8.1

The background sound level is an underlying level of sound over a period, T , and might in part be an indication of relative quietness at a given location. It does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds.

In using the background sound level in the method for rating and assessing industrial and commercial sound it is important to ensure that values are reliable and suitably represent both the particular circumstances and periods of interest. For this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods.

Among other considerations, diurnal patterns can have a major influence on background sound levels and, for example, the middle of the night can be distinctly different (and potentially of lesser importance) compared to the start or end of the night-time period for sleep purposes. Furthermore, in this general context it can also be necessary to separately assess weekends and weekday periods.

Since the intention is to determine a background sound level in the absence of the specific sound that is under consideration, it is necessary to understand that the background sound level can in some circumstances legitimately include industrial and/or commercial sounds that are present as separate to the specific sound.

Care is necessary in circumstances where background sound levels are low to ensure that self-generated and electrical noise within the measurement system does not unduly influence reported values, which may be the case if the measured background sound levels are less than 10 dB above the noise floor of the measuring system.

- 8.1.1** As appropriate, for each of the following situations, conduct background sound level measurements under weather conditions that are representative and comparable to the weather conditions when the specific sound occurs or could occur:
- a) a new specific sound source is to be commissioned (see [8.2](#)); or
 - b) a change or modification is to be made to an existing sound source (see [8.2](#)); or
 - c) there is an existing specific sound source not operating continuously (see [8.3](#)); or
 - d) there is an existing specific sound source operating continuously (see [8.4](#)); or
 - e) a new noise-sensitive receptor is being introduced to an environment already experiencing, or that will at a future time experience, industrial and/or commercial sound (see [8.5](#)).
- 8.1.2** Where possible, measure the background sound level at the assessment location(s). If this is not possible measure at an alternative location where the residual sound is comparable to the assessment location(s). A detailed justification for considering this should be reported.
- NOTE* In determining whether an alternative location is suitable for carrying out measurements of the background sound level it is important to take account of all contributing factors that might influence the measurement and assessment procedure. As far as is practicable, uncertainty in any measurement at an alternative location should be minimized and the extent of uncertainty be reported.
- 8.1.3** Ensure that the measurement time interval is sufficient to obtain a representative value of the background sound level for the period of interest. This should comprise continuous measurements of normally not less than 15 min intervals, which can be contiguous or disaggregated.
- 8.1.4** The monitoring duration should reflect the range of background sound levels for the period being assessed. In practice, there is no “single” background sound level as this is a fluctuating parameter. However, the background sound level used for the assessment should be representative of the period being assessed.

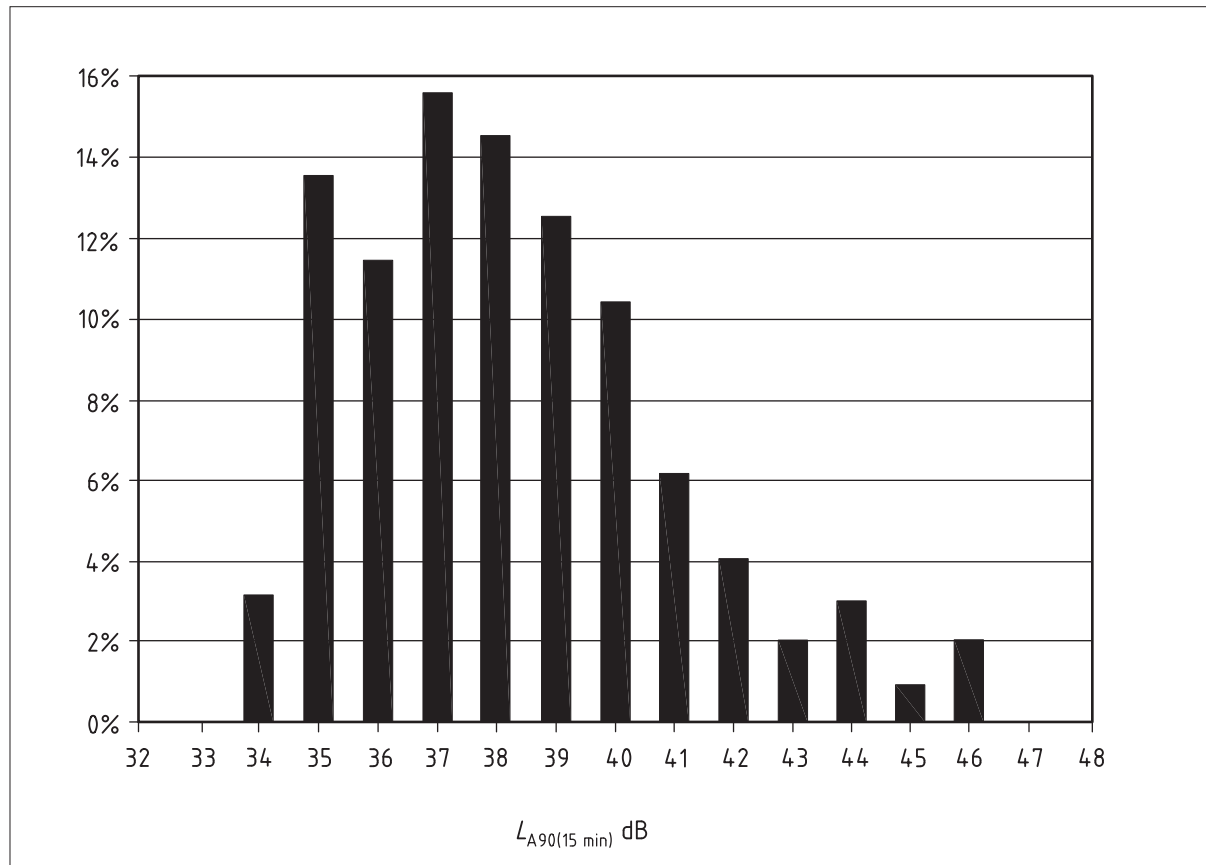
NOTE 1 To obtain a representative background sound level a series of either sequential or disaggregated measurements should be carried out for the period(s) of interest, possibly on more than one occasion. A representative level should account for the range of background sound levels and should not automatically be assumed to be either the minimum or modal value.

NOTE 2 The mean average of a series of measured background sound levels is not numerically equal to the overall period background sound level that would otherwise be obtained by a single measurement spanning individual measurement periods.

NOTE 3 Background sound can be significantly affected by meteorological conditions, particularly where the main sources of residual sound are remote from the assessment location(s).

NOTE 4 [Figure 4](#) shows an example of a statistical analysis of the results of all the measurement periods in order to determine a background sound level. For this distribution of the data an $L_{A90(15 \text{ min})}$ of 37 dB was considered to be representative and in this instance was also the most commonly occurring value.

Figure 4 — Example of a statistical analysis to determine the background sound level



8.1.5 To fully understand the context in which the sound from an industrial and/or commercial source(s) is being assessed, describe and report the sources of sound which comprise the acoustic environment.

8.2 Proposed, new, modified or additional specific sound source(s)

Measure the background sound level at times when the specific sound source(s) is intended to be operated.

8.3 Existing specific sound source(s) not operating continuously

Measure the background sound:

- during a temporary shutdown of the specific sound source(s); or
- during a period immediately before or after the specific sound source(s) operate(s); or
- at times when the specific sound is absent but may otherwise be present over the period of interest.

8.4 Existing specific sound source(s) operating continuously

Measure the background sound at a location which is not subject to the specific sound and where the residual sound is considered to be comparable to that of the assessment location. Justification for considering this should be reported.

8.5 Introduction of a new noise-sensitive receptor

Measure the background sound at the intended location of any new noise-sensitive receptor(s) in the absence of any specific sound.

NOTE Where a new noise-sensitive receptor is introduced and there is extant industrial and/or commercial sound, it should be recognized that the industrial and/or commercial sound forms a component of the acoustic environment. In such circumstances other guidance and criteria in addition to or alternative to this standard can also inform the appropriateness of both introducing a new noise-sensitive receptor and the extent of required noise mitigation.

8.6 Precision when reporting the sound level measured

There can be variability in the derivation of statistical parameters, so use integers when expressing the background sound level.

NOTE 1 A background sound level expressed to a precision of one decimal place implies incorrectly that the background sound level is exactly that value.

NOTE 2 Rounding is to be done on the basis that a value of 0.5 is rounded up.

9 Rating level

9.1 General

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level. This can be approached in three ways:

- a) subjective method;
- b) objective method for tonality;
- c) reference method.

NOTE 1 Sound with prominent impulses has been shown to be more annoying than continuous types of sound (without impulses or tones) with the same equivalent sound pressure level.

NOTE 2 The rating level is equal to the specific sound level if there are no such features present or expected to be present.

9.2 Subjective method

Where appropriate, establish a rating penalty for sound based on a subjective assessment of its characteristics. This would also be appropriate where a new source cannot be measured because it is only proposed at that time but the characteristics of similar sources can subjectively be assessed.

Correct the specific sound level if a tone, impulse or other characteristic occurs, or is expected to be present for new or modified sound sources.

NOTE 1 The prominence of tonal or impulsive sound from a source can be masked by residual sound. In many cases the amount of masking varies as the residual sound changes in level and possibly character. The source's tonal and/or impulsive characteristics could also vary with time.

Consider the subjective prominence of the character of the specific sound at the noise-sensitive locations and the extent to which such acoustically distinguishing characteristics will attract attention.

COMMENTARY ON 9.2

Tonality

For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible.

Impulsivity

A correction of up to +9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible.

NOTE 2  If characteristics likely to affect perception and response are present in the specific sound, within the same reference period, then the applicable corrections ought normally to be added arithmetically. However, if any single feature is dominant to the exclusion of the others then it might be appropriate to apply a reduced or even zero correction for the minor characteristics. 

Intermittency

When the specific sound has identifiable on/off conditions, the specific sound level should be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time. This can necessitate measuring the specific sound over a number of shorter sampling periods that are in combination less than the reference time interval in total, and then calculating the specific sound level for the reference time interval allowing for time when the specific sound is not present. If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.

Other sound characteristics

Where the specific sound features characteristics that are neither tonal nor impulsive, nor intermittent, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied. 

9.3 Objective methods

9.3.1 General

If the subjective method is not sufficient for assessing the audibility of tones in sound or the prominence of impulsive sounds, use the one-third octave method in 9.3.2 and/or the reference methods in 9.3.3, as appropriate.

The precision used in the assessment should be appropriate to the method chosen and the uncertainties associated with it. If the reference method approach is adopted it might be appropriate to work to a precision of one decimal place and then round the rating level to the nearest integer value. If an approximation value is used then integer values should be used throughout.

NOTE 1 The uncertainty in assessing community response to sound from industrial and commercial sources makes the use of a precision of one decimal place inappropriate.

NOTE 2 Rounding is to be done on the basis that a value of 0.5 is rounded up.

9.3.2 One-third octave method

Identify tones using the method given in [Annex C](#), then add a correction of 6 dB if a tone is present.

9.3.3 Reference methods

When the one-third octave method is not sufficient, use the reference method for assessing the audibility of tones given in [Annex D](#), which produces a penalty on a sliding scale from 0.0 dB to 6.0 dB.

Use the reference method given in [Annex E](#) for measuring the prominence of impulsive sounds, which produces penalties in the range 0.0 dB to 9.0 dB.

NOTE Where tonal and impulsive characteristics are present in the specific sound within the same reference period then these two corrections can both be taken into account. If one feature is dominant then it might be appropriate to apply a single correction. Where both features are likely to affect perception and response, the corrections should normally be added $\overline{A_1}$ arithmetically $\overline{A_1}$.

10 Uncertainty

10.1 General

Consider the level of uncertainty in the data and associated calculations. Where the level of uncertainty could affect the conclusion, take reasonably practicable steps to reduce the level of uncertainty. Report the level and potential effects of uncertainty.

10.2 Uncertainty of measured values

Report the reasoning for the selected measurement method, together with steps taken to reduce measurement uncertainty.

NOTE The level of uncertainty associated with a measurement of sound level depends upon a number of factors, including:

- a) the complexity of the sound source and the level of variability in sound emission from the source;
- b) the complexity and level of variability of the residual acoustic environment;
- c) the level of residual sound in the presence of the specific sound at the measurement location;
- d) the location(s) selected for taking the measurements;
- e) the distance between sources of sound and the measurement location and intervening ground conditions;
- f) the number of measurements taken;
- g) the measurement time intervals;
- h) the range of times when the measurements have been taken;
- i) the range of suitable weather conditions during which measurements have been taken;
- j) the measurement method and variability between different practitioners in the way the method is applied;
- k) the level of rounding of each measurement recorded; and
- l) the instrumentation used.

An appreciation of the uncertainties in the measurement is likely to lead to a better understanding of the measurement, its potential variability and any implications in the reported findings of the assessment. In such instances, where the level of uncertainty is too great, it might be necessary to repeat measurements or to take other steps to obtain the desired confidence in the results.

Although the level of uncertainty due to the instrumentation system can be quantified, this is unlikely to be practicable for some of the other measurement uncertainties. The level of uncertainty can be reduced by several methods, including taking more measurements, for longer measurement time intervals, on different occasions over longer periods of time, under differing suitable weather conditions. What is appropriate will depend upon the

particular circumstances of each assessment, including the scale of the proposed development and the risk of it causing significant adverse impact. Consideration should be given to any published information that is relevant to the assessment.

10.3 Uncertainty in calculations

COMMENTARY ON 10.3

Uncertainty in calculating sound levels can arise from:

- a) uncertainty in any measured sound levels used in the calculations;*
- b) uncertainty in the operation or sound emission characteristics of the specific sound source and any assumed sound power levels;*
- c) uncertainty in the calculation method;*
- d) simplifying the real situation to “fit” the model (user influence on modelling); and*
- e) error in the calculation process.*

Where the sound power level is used for calculating sound pressure levels, it should be representative of the source and the conditions under which the source is expected to operate.

Where possible, use recognized standards to establish the sound power level and the uncertainty (e.g. BS EN ISO 3740 and BS EN ISO 3747). Where it is not possible to use appropriate standards, describe the method of establishing the sound power level, report the uncertainty and state the reasons for using this method.

Use a validated method of calculating sound levels, e.g. ISO 9613-2 or similar. If an alternative calculation method is used, fully describe the method and state the reasons for using this method.

Check the implementation of the calculation method for errors.

For simple cases, e.g. where the level of variability in sound propagation resulting from changes in meteorological conditions is likely to be small, simple calculation methods might be sufficient.

11 Assessment of the impacts

COMMENTARY ON 11

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level (see Clause [8](#)) from the rating level (see Clause [9](#)).

NOTE 1 More than one assessment might be appropriate.

- a) Typically, the greater this difference, the greater the magnitude of the impact.*
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*
- d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where*

the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

NOTE 2 Adverse impacts may include but not be limited to annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

Where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration, including the following.

- 1) The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.

Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.

Where residual sound levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse.

- 2) The character and level of the residual sound compared to the character and level of the specific sound. Consider whether it would be beneficial to compare the frequency spectrum and temporal variation of the specific sound with that of the ambient or residual sound to assess the degree to which the specific sound source is likely to be distinguishable and will represent an incongruous sound by comparison to the acoustic environment that would occur in the absence of the specific sound. Any sound parameters, sampling periods and averaging time periods used to undertake character comparisons should reflect the way in which sound of an industrial and/or commercial nature is likely to be perceived and how people react to it.

NOTE 3 Consideration should be given to evidence on human response to sound and, in particular, industrial and/or commercial sound where it is available. A number of studies are listed in the "Effects on humans of industrial and commercial sound" portion of the "Further reading" list in the Bibliography.

- 3) The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as:
 - i) facade insulation treatment;
 - ii) ventilation and/or cooling that will reduce the need to have windows open so as to provide rapid or purge ventilation; and
 - iii) acoustic screening.

12 Information to be reported

Report the following, as appropriate.

- a) Statement of qualifications, competency, professional memberships and experience directly relevant to the application of this British Standard of all personnel contributing to the assessment.
- b) Source being assessed as follows:
 - 1) description of the main sound sources and of the specific sound;
 - 2) hours of operation;

- 3) mode of operation (e.g. continuous, twice a day, only in hot weather);
 - 4) statement of operational rates of the main sound sources (e.g. maximum load setting, 50% max rate, low load setting); and
 - 5) description of premises in which the main sound sources are situated (if applicable).
- c) Subjective impressions, including:
- 1) dominance or audibility of the specific sound; and
 - 2) main sources contributing to the residual sound.
- d) The existing context (see [Clause 4](#) and [Clause 11](#)), including an assessment of the sensitivity of the receptor **[A1]** *Text deleted* **[A1]**.
- e) Measurement locations, their distance from the specific sound source, the topography of the intervening ground and any reflecting surface other than the ground, including a photograph, or a dimensioned sketch with a north marker. A justification for the choice of measurement locations should also be included.
- f) Sound measuring systems, including calibrator or pistonphone used:
- 1) type and/or model;
 - 2) manufacturer;
 - 3) serial number; and
 - 4) details of the latest verification test including dates.
- g) Operational test:
- 1) reference level(s) of calibrator, multi-function calibrator or pistonphone; and
 - 2) meter reading(s) before and after measurements with calibrator, multi-function calibrator or pistonphone applied.
- h) Weather conditions, including:
- 1) wind speed(s) and direction(s);
 - 2) presence of conditions likely to lead to temperature inversion (e.g. calm nights with little cloud cover);
 - 3) precipitation;
 - 4) fog;
 - 5) wet ground;
 - 6) frozen ground or snow coverage
 - 7) temperature; and
 - 8) cloud cover.
- i) Date(s) and time(s) of measurements.
- j) Measurement time intervals.
- k) Reference time interval(s).
- l) **[A1]** Measured sound level(s):
- 1) residual sound level(s) and method of determination;
 - 2) ambient sound level(s) and method of determination;
 - 3) specific sound level(s) and method of determination;