Environmental Noise Guidance for Local Authority Planning & Enforcement Departments

Advice for local authority officers involved in enforcement, assessment of noise reports, & drafting of noise conditions for planning permissions & permits

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About the AACI

The Association of Acoustic Consultants of Ireland is a trade association for qualified acoustic, noise and vibration consultancy practices in the Republic of Ireland. The association was set up to best represent the interests of acoustics professionals working in Ireland. One of the core objectives of the AACI is to assist in shaping and progressing the acoustics industry as it continues to grow. This is achieved through assisting in the preparation of noise guidance documents, and in the design and review of acoustic standards on behalf of the NSAI. The AACI aims to ensure that the expertise of qualified professionals is adequately recognised by relevant authorities.

http://www.aaci.ie

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Foreword

Most regulation of environmental noise issues in the Republic of Ireland is undertaken through Local Authorities. Outside of certain specified industrial, waste and agricultural sectors regulated by the Environmental Protection Agency, Local Authorities regulate most sources. This is mainly undertaken through Planning & Development legislation, whereby noise conditions are attached to a planning permission. Noise conditions may also be attached to other consents such as waste permits.

Through the planning/permit application process, Local Authority Officers are involved with the initial appraisal of potential noise impacts, the requesting of additional information, the drafting of noise conditions, the subsequent assessment of compliance, the investigation of alleged non-compliance, and the initiation of legal action. Legal action may be initiated through Planning & Development legislation, where conditions have been shown to be breached, or through the Environmental Protection Agency Act 1992 and its subsequent instruments, which make provision for legal action where a nuisance is shown to exist.

Given the prominent role of Local Authorities in the management of environmental noise, relevant noise guidance is considered important to promote an appropriate and consistent approach. It is surprising that a relevant guidance document has not been issued to date by the government or its agencies, similar to the *National protocol for dealing with noise complaints for local authorities* (EPA and Network for Ireland's Environmental Compliance & Enforcement, 2016). In the absence of any such document, each Local Authority has tended to approach environmental noise issues differently, resulting in an inconsistent approach across the country. This is understandable, given the complex nature of noise.

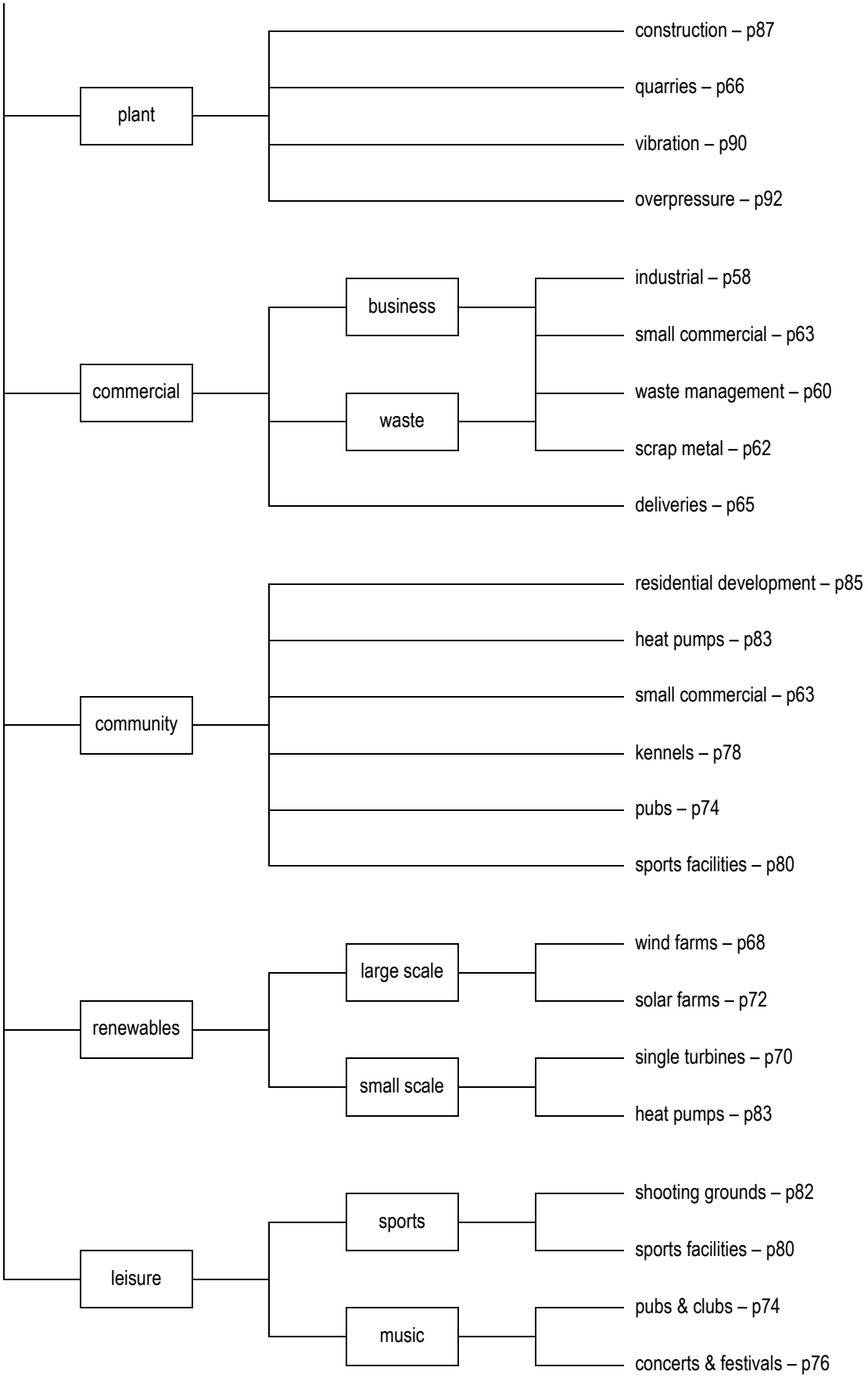
This document aims to clearly set out advice for Local Authority Officers working in Planning and Environment Departments. It is hoped that the document will introduce some degree of consistency between Local Authorities. It is also hoped that the document will provide a one-stop reference for Officers, thus reducing time spent searching for relevant guidance. Optimally worded noise conditions will reduce the risk of issues created by poorly worded conditions.

It is important to note that this document merely seeks to provide guidance. The document does NOT purport to be a dictatorial manual. It is hoped that Local Authorities will find the document useful in their day-to-day management of environmental noise issues.

The document is divided into three parts as follows:

- Part 1: Scope, terminology & measurement.
- Part 2: General guidance for Local Authority Officers.
- Part 3: Sector specific guidance.

AACI guidance tree



PART 1:

SCOPE, TERMINOLOGY & MEASUREMENT

1. Scope

This document relates to environmental noise issues encountered regularly by Local Authority Officers. Issues typically encountered, and to which this document relates, include:

- Assessment of noise content of environmental reports, planning applications, waste permits, and similar applications.
- Identification of situations where furnished information is insufficient, and the scoping and drafting of further information requests.
- Drafting of noise conditions for attachment to planning permission, permits and similar consents.
- Assessment of compliance with noise conditions, either through direct measurement, or appraisal of noise reports submitted by site operators or their agents.

Typical sectors to which this document relates include:

- Industrial developments, waste management facilities and other facilities, outside of those regulated by the EPA.
- Large and small commercial developments, including business parks, grain drying facilities, food production facilities, etc.
- Residential and mixed residential/commercial developments, including potential inward impacts from road traffic and other sources.
- Renewable energy projects including wind farms and solar farms.
- Multi-use games areas (MUGAs) and similar facilities.
- Bars, clubs and hotels where amplified music and any other emissions may arise.
- Boarding kennels.
- Shooting grounds.
- Quarries.

Noise emissions from installations subject to EPA regulation are beyond the remit of Local Authorities. However, the construction phase of such developments is subject to Local Authority control, and this document includes a review of construction noise guidance.

Noise sources not addressed in this document include:

- Operational noise emissions from installations regulated by the EPA.
- Workplace noise emissions, which are subject to regulation by the Health & Safety Authority.

Ground borne vibration is briefly discussed in the document, as noise and vibration are typically assessed together.

2. Terminology

The assessment of environmental noise may initially appear complicated due to the use of several terms, most with suffixes of varying complexity. This section identifies the terms most commonly encountered by Local Authority Officers, and attempts to explain each one.

dB

The decibel (dB) is the unit of the sound measurement scale. It is not a simple linear unit like the metre or the second, but is instead based on a logarithmic ratio. The Local Authority Officer is unlikely to require an in-depth knowledge of the workings of the dB. However, it is important to note that dB levels cannot be added or subtracted. Thus two sources of 41 dB and 48 dB do not result in a total level of 89 dB. If an initial source of 65 dB is doubled (for example due to switching on a second identical unit), the total level emitted is not 130 dB, but in fact 68 dB.

The conventional approach in environmental noise assessments, outside of calculations, is to round all dB values to the nearest whole number. The reason for this is that quoting a result of say 63.1 dB implies an accuracy which, in reality, is unachievable due to uncertainties and variations in the noise environment, the equipment, and the monitoring methodology.

It is useful to note that a difference of 3 dB is usually the smallest change perceptible by the human ear. An increase/reduction of 10 dB is typically perceived as a doubling/halving of the sound level. Examples of decibel levels are shown in Figure 1.

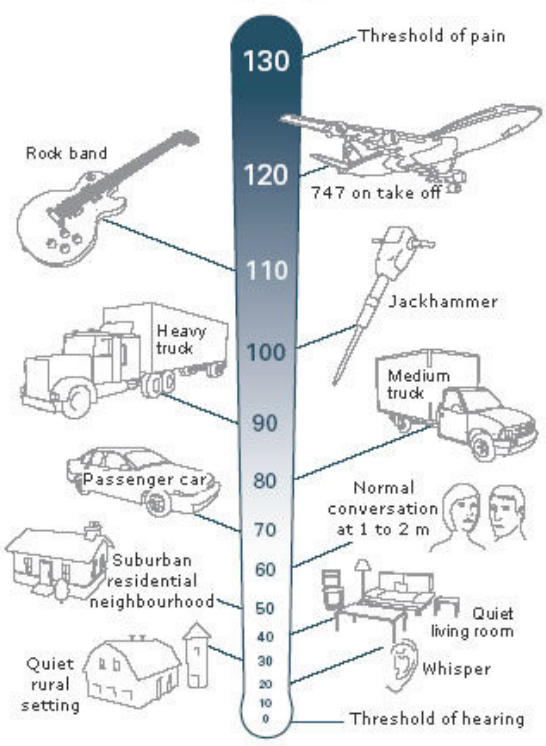


Figure 1: The dB scale. Levels presented are typical $L_{Aeq\,T}$ values.

L_{eq}

The L_{eq} (pronounced ‘el-ee-cue’) is the most commonly used parameter in environmental noise surveys. L_{eq} is shorthand for ‘equivalent continuous level’, which describes the total amount of acoustic energy present at a location. Although not strictly correct, the L_{eq} can be thought of as the average noise level present in the environment. More accurately, the L_{eq} is a descriptor of the average sound pressure level, although sound pressure level and noise level are often used interchangeably.

The reason why this parameter appears so commonly is that a large number of social surveys undertaken around the world over the last few decades have shown that the L_{eq} level appears to best approximate the reaction of the typical listener. An important word here is ‘typical’. It is acknowledged that the L_{eq} does not perfectly represent all listeners. For instance, persons with hypersensitive hearing, or those who are inclined to complain in any case, may not be satisfied with L_{eq} levels which are deemed satisfactory by most other listeners.

Despite attempts by many experts to devise alternative metrics to quantify environmental noise levels, the L_{eq} continues to be the most widely adopted. A number of metrics are based around the L_{eq}, correcting for factors such as the number of noise events, and the time of day when such events occur.

A-weighting

When a sound level meter measures the total noise present at a location, it measures the sound pressure level across a wide range of frequencies. These include low frequencies (hums and bass), mid frequencies (speech, and most sounds that humans hear) and higher frequencies (squeaks, birdsong, etc.). The sound level meter calculates the sound pressure level in each of these frequencies, aggregates them, and the resulting value can be expressed as the L_{eq} described above.

During the social surveys mentioned above, experts noticed that the typical human ear does not correlate exactly with a sound level meter. They observed that the ear is biased towards mid frequencies, as the ear evolved to become most sensitive to noise sources prevalent in the surrounding environment. The ear is most responsive to frequencies between 500 Hz and 8 kHz, and is less responsive to low-pitch or high-pitch noises.

In order to account for this bias, experts devised a weighting, termed the ‘A-weighting’, to mimic the bias of the ear. This is the most commonly used weighting in noise measurements. Like the human ear, the A-weighting effectively reduces the impact of the lower and higher frequencies that the average person hears less clearly, and is used to provide a true representation of what the typical human ear actually hears. The A-weighting can be selected on the sound level meter along with other frequency weighting options before measurement sampling commences.

L_{Aeq}

Noise levels measured across the various frequencies by a sound level meter can be subjected to the A-weighing, and the aggregated result, termed the L_{Aeq}, is reasonably representative of the corresponding noise level heard by the ear and received by the brain.

Almost all environmental noise surveys involve the L_{Aeq} parameter. The parameter is based on the L_{eq} parameter discussed above, with the added A-weighting correction. For many years, application of the A-weighting was denoted by the addition of an A to the dB result i.e. dBA. Thus the L_{eq} level might have been reported as 65 dBA. In recent years, the trend has been to include the A with the L_{eq}, i.e. the L_{Aeq} level is 65 dB. Either is acceptable. For clarity, the Local Authority Officer should always confirm that the L_{eq} result is A-weighted.

$L_{Aeq\ T}$

The L_{Aeq} parameter is meaningless unless some information is provided regarding the duration of time over which it has been measured. The L_{Aeq} describes the average sound pressure level (A-weighted), and it is important to know over what duration the level has been averaged.

Take, for instance, a measurement recorded at the boundary of a factory, where noise emissions come and go due to various machines starting and stopping, and where mobile plant passes by at intervals. The L_{Aeq} measured over five minutes might be very different to the L_{Aeq} recorded over one hour, particularly if there is an obvious pattern to the noise emissions. If the factory has one loud period every hour, lasting say 20 minutes, the L_{Aeq} level measured during that 20 minute period will obviously be higher than the L_{Aeq} level measured during any period outside those 20 minutes. A measurement interval of one hour will average out these fluctuations. The longer the measurement interval, the more likely it will completely average out a short loud event, thus minimising its impact. Therefore a balance has to be struck when selecting measurement duration.

Measurement durations commonly applied are 15 minutes, 30 minutes, or one hour. Certain guidance documents make recommendations for specific sectors e.g. a one hour interval is recommended for quarry emissions. Wind farm emissions are usually assessed over 10 minute intervals, for historic reasons.

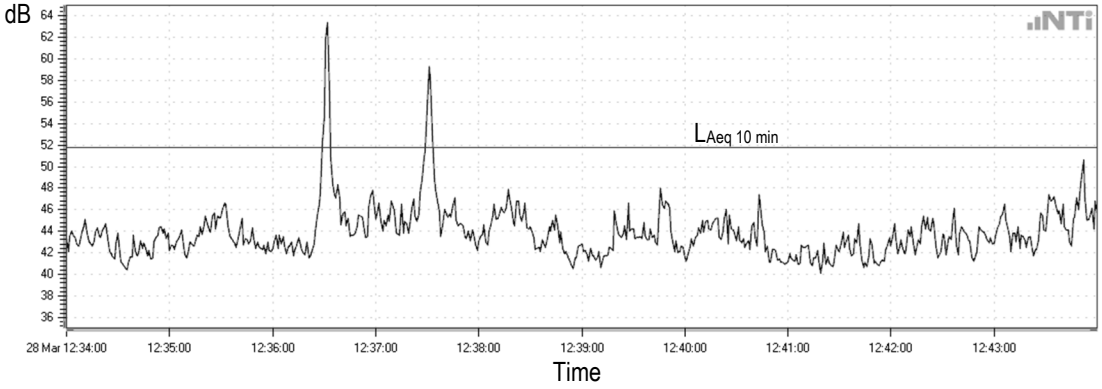
The measurement duration is indicated by T in $L_{Aeq\ T}$. Thus parameters such as the $L_{Aeq\ 15\ min}$, $L_{Aeq\ 30\ min}$ and $L_{Aeq\ 1\ h}$ value are quoted regularly. The duration T should be clearly evident in all noise reports. Most noise assessments and compliance reports are based around the $L_{Aeq\ T}$ parameter.

Where a noise source is relatively steady, $L_{Aeq\ 15\ min}$, $L_{Aeq\ 30\ min}$ and $L_{Aeq\ 1\ h}$ levels are likely to be similar. In such cases, the measured $L_{Aeq\ 15\ min}$ level is likely to be reasonably representative of $L_{Aeq\ T}$ levels measured over longer durations, assuming that no extraneous sources of significance are audible.

It may not always be appropriate to apply a long measurement duration, as such a duration may minimise the effects of short duration noise events or peaks. Such short duration events may give rise to considerable impacts at a noise sensitive location. Thus careful consideration must be given to the specified measurement time interval T in each instance, relative to the expectant characteristics of the noise source under consideration. Selection of measurement interval T is discussed further in Section 8.

Figure 2 shows the typical relationship between the sound pressure level measured each second, and the overall $L_{Aeq\ T}$ value subsequently calculated by the sound level meter.

Figure 2: A typical time history profile measured over 10 minutes, showing the changing sound pressure level each second, and the corresponding $L_{Aeq\ 10\ min}$ value. In this case, the $L_{Aeq\ 10\ min}$ value (52 dB) is elevated above most of the profile due to intrusion from two passing cars between 1236 h and 1238 h.



$L_{AF10\ T}$ & $L_{AF90\ T}$

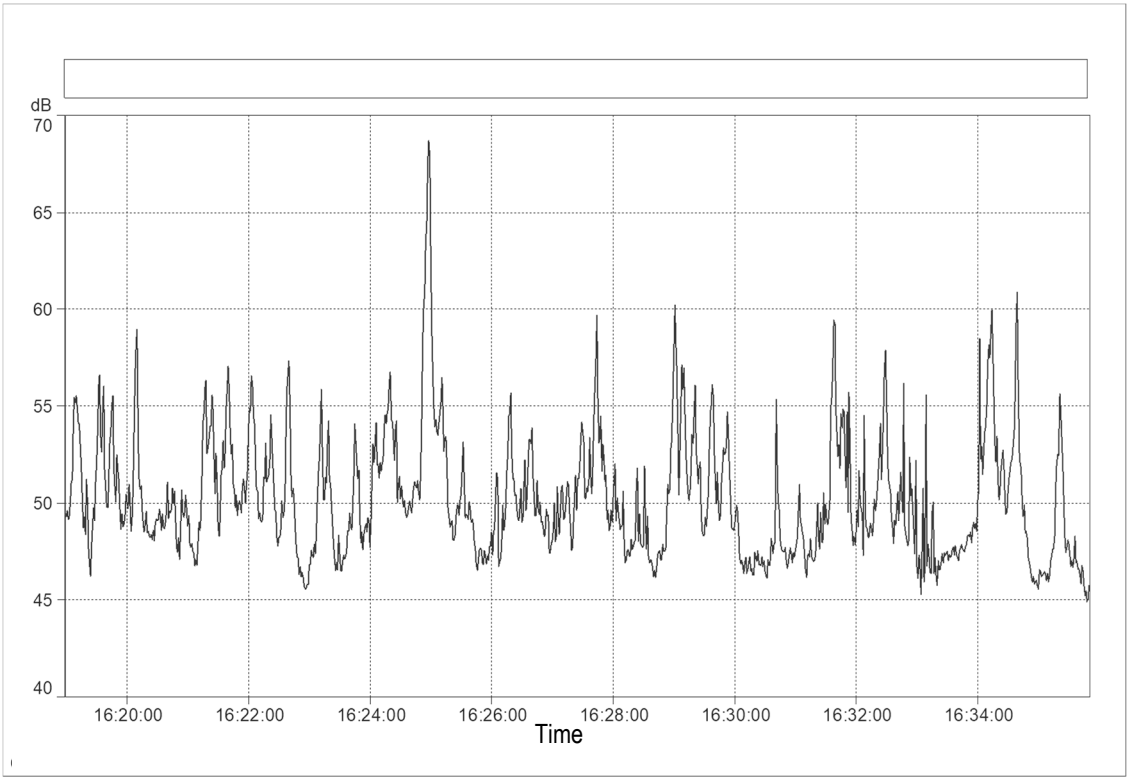
Three parameters are typically quoted in environmental noise surveys. The first is the $L_{Aeq\ T}$ described above. The other two are the $L_{AF10\ T}$ and $L_{AF90\ T}$. These are statistical parameters, and are useful in providing some additional information about the noise environment surveyed.

A brief comment on the 'F' in these parameters is first warranted. Historically, sound level meters displayed results using a moving needle. If the needle moved back and forth too quickly on the display, which it invariably did, the user could slow down its reaction by activating a 'Slow' function. This sampled the information forwarded by the microphone less often. Modern digital sound level meters no longer use analogue displays, and the microphone signal is processed using the default 'Fast' function. This is represented by the 'F' in $L_{AF10\ T}$, $L_{AF90\ T}$ and other parameters. Most measurements are now undertaken using the 'F' function. Where the 'F' is not specifically indicated, it may generally be assumed that the measurements are Fast weighted (although such an assumption may be imprudent with respect to the L_{AFmax} parameter, discussed below).

A sound level meter using the 'F' function logs in its memory the noise level eight times each second. The highest value each second is typically shown on the screen. After a measurement interval of say 30 minutes, the statistical spread of all the measured

levels may be used to draw some conclusions about the noise environment. For instance, each time a car passes, the noise level will rise and fall. The more cars pass, the more spikes will occur. A plot of levels measured each second, such as that shown in Figure 3, will often show a noise floor. In Figure 3, this floor is around 47 dB. When the noise environment quietens, in between passing cars, the level will tend to decrease towards this floor. In contrast, the level will rise to over 50 dB when cars pass, and may approach 60 dB.

Figure 3: Example of a noise plot, showing the noise level recorded each second.



Looking at Figure 3, it is evident that noise levels were above the floor for approximately 90 % of the time. In fact, the sound level meter informs us that the noise level in that particular case was higher than 47 dB for 90 % of that particular measurement interval. This parameter is denoted the $L_{AF90\ T}$, which simply describes the noise level that was exceeded for 90 % of measurement interval T. In Figure 3, where the interval was 15 minutes and the $L_{AF90\ 15\ min}$ value was 47 dB, this indicates that the noise level was higher than 47 dB for a total of 13.5 minutes. In a quieter environment, the $L_{AF90\ 15\ min}$ value would have been lower. For this reason, night-time $L_{AF90\ T}$ values are generally lower than daytime values, typically 10 dB lower or more. $L_{AF90\ T}$ values are usually kept elevated by distant road traffic and other continuously present sources.

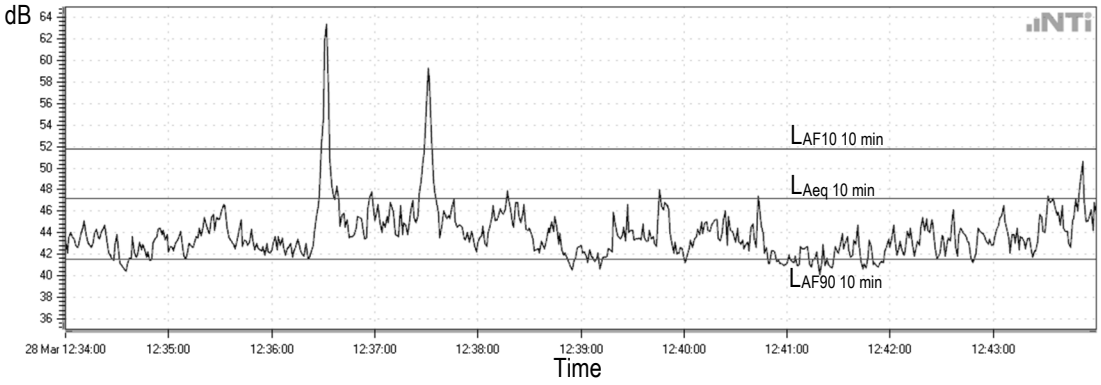
The $L_{AF10\ T}$ is the noise level exceeded for 10 % of the time. This is often used to describe the noise level associated with passing traffic – not continuously audible traffic in the distance, but rather local traffic movements which temporarily drown out other noise sources. In Figure 3, the $L_{AF10\ 15\ min}$ level was 55 dB. It can be inferred that the noise level due to passing local traffic was 55 dB. The high spike at 1625 h was due to

a noisy motorbike. If the motorbike had not passed, the $L_{AF10\ 15\ min}$ level would have fallen to approximately 53 dB.

In a typical noise environment, the $L_{Aeq\ T}$ will usually lie somewhere between the L_{AF10T} and $L_{AF90\ T}$ (usually closer to the former). For instance, the $L_{Aeq\ 15\ min}$ level in Figure 3 was 52 dB, which lies between the $L_{AF10\ T}$ and $L_{AF90\ T}$ levels. The $L_{Aeq\ T}$ level may exceed the $L_{AF10\ T}$ if a small number of short loud events occurred.

Figure 4 shows again the time history profile from Figure 2 above, this time with the $L_{AF10\ 10\ min}$ and $L_{AF90\ 10\ min}$ values shown. This figure demonstrates the typical spread between these statistical values and the $L_{Aeq\ T}$ value.

Figure 4: Time history profile taken from Figure 2, with the two most commonly applied statistical parameters added.

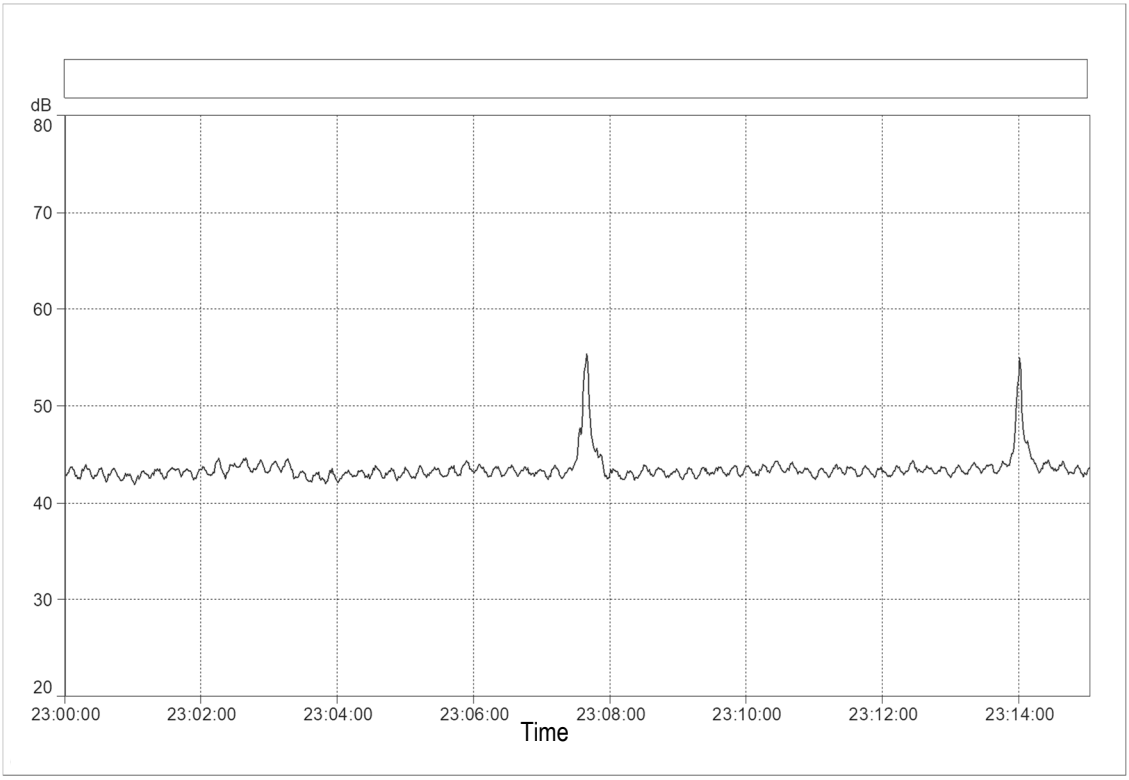


With experience, it becomes possible to draw conclusions about the noise environment based on the spread between the L_{AF10T}, $L_{Aeq\ T}$ and $L_{AF90\ T}$ values. The Local Authority Officer is unlikely to require this level of knowledge. However, it is important that all three parameters are presented in a noise report with respect to each interval measured.

One final point is worth noting here with respect to the $L_{AF90\ T}$ value. Because this value lies just above the noise floor as described above, it may reasonably be used to describe the noise level from a continuously present source. For example, if the noise environment at a measurement location is dominated by continuous steady emissions from a source such as a fan, the noise floor will more or less sit at the level generated by the fan. Thus the $L_{AF90\ T}$ level measured will be representative of fan emissions. This applies to any continuous and steady source such as a fan, generator, air management system, quarry washing plant, etc.

Figure 5 shows a plot measured during night-time hours near a factory where air management emissions were continuous and steady (although the emissions wavered by 1-2 dB every 6-8 seconds). Two cars passed nearby during the interval. The $L_{Aeq\ 15\ min}$ level measured was 44 dB. This was due to the factory emissions combined with both car passes. When the cars were excluded from the data (which is possible with some modern software packages), the $L_{Aeq\ 15\ min}$ level dropped to 42 dB. It can be inferred that the contribution due solely to the factory was therefore 42 dB. The $L_{AF90\ 15\ min}$ level for this period was also 42 dB, even without excluding the cars. It follows that, in this case, the $L_{AF90\ 15\ min}$ level was representative of the factory.

Figure 5: Another noise plot, recorded close to a steady factory source.



From the foregoing, it is evident that the $L_{AF10\ T}$ and $L_{AF90\ T}$ are useful parameters, particularly the latter which is usually used to describe the 'background' noise level. The $L_{AF90\ T}$ may also be used to represent a continuous and steady noise source. Local Authority Officers will commonly see this technique applied in compliance noise reports. Although the technique is valid, the Officer should be satisfied that the character of the source (i.e. steady, continuous, or otherwise) is suitable for description by the $L_{AF90\ T}$ parameter.

The $L_{AF10\ T}$ and $L_{AF90\ T}$ are the most commonly used statistical parameters. Any statistical value can be readily calculated by most sound level meters and software. On occasion, $L_{AF50\ T}$, $L_{AF95\ T}$ and other values may be quoted for various reasons. Usage of such parameters should always be explained in a noise report.

L_{AFmax} & L_{AFmin}

The L_{AFmax} and L_{AFmin} describe respectively the highest and lowest values logged by the sound level meter during the measurement interval. As mentioned above, a sound level meter records noise levels eight times each setting using the 'F' function. Thus, over a 15 minute interval, there will be 7200 values logged by the meter. The highest and lowest of these are denoted the L_{AFmax} and L_{AFmin}.

Both parameters have their uses, although do not appear in every noise report. The L_{AFmax} is reported more regularly. In many environmental noise surveys, the L_{AFmax} often relates to an extraneous source such as local birdsong, a passing car or an accidental tap on the sound level meter, and therefore may be of limited relevance.

One of the few occasions where the 'S' (Slow) time function might be used is when reporting the L_{ASmax}. This is sometimes seen with respect to construction noise measurements, chiefly due to its reference in a construction noise guidance document issued previously by the National Roads Authority (now Transport Infrastructure Ireland). The L_{ASmax} will typically be several decibels lower than the corresponding L_{AFmax}, as the slower sampling rate (measured once each second rather than eight times each second) is likely to miss the very highest peaks.

L_{WA}

The $L_{Aeq\ T}$ describes the sound level (more correctly called the sound pressure level, but both are used interchangeably) at a given location, over time interval T. With respect to a particular source, such as a compressor for example, the $L_{Aeq\ T}$ describes the sound pressure level attributable to the compressor at the measurement position. In reports relating to noise level prediction, the distance to the source should always be given with respect to $L_{Aeq\ T}$ levels. Thus the $L_{Aeq\ T}$ due to the compressor may be 68 dB at 5 m. Given that a source such as a compressor is likely to be steady and unfluctuating, a short measurement of two minutes, or even one minute, is likely to be sufficient.

The $L_{Aeq\ T}$ value attributable to the compressor at the measurement position will obviously be dependent on distance from the compressor. It will also depend on other factors such as:

- Local walls, floors and ceilings, which reflect noise.
- Intervening structures which may partially or entirely block line of sight.
- Mounting arrangement – the compressor may be loose in its fittings, giving rise to rattles.
- Condition – panels and connections may be loose, parts may be worn, etc.
- Directivity – some sources emit more strongly in certain directions, due to the position of motors, exhausts, etc.

In noise assessment reports, it is often necessary to predict noise levels due to one or more proposed sources. One method used is to measure the $L_{Aeq\ T}$ level at a specified distance from an existing source, and to use this level to form the basis of calculations. However, care needs to be taken that the $L_{Aeq\ T}$ level measured near the existing source is representative. As noted above, local factors may affect the measured $L_{Aeq\ T}$. In addition, the measurement position needs to be located in the far field (i.e. not in the near field, where sound waves originating from all points on the source can combine to produce complicated acoustic patterns). Far field conditions will usually be achieved by locating the $L_{Aeq\ T}$ measurement position at a distance which is at least twice the largest dimension of the source in question, and at least twice the lowest wavelength of significance.

Where noise levels from an existing or similar source cannot be measured, an alternative is to obtain the L_W or L_{WA} value from the supplier or manufacturer. This describes the sound power level of a source, which may or may not be A-weighted. The sound power level is a measure of how much noise a source emits into the

surrounding space. The L_W/L_{WA} is commonly used to form the basis of predictive modelling. Most L_W/L_{WA} values quoted by manufacturers have been obtained by measuring $L_{Aeq\ T}$ levels at certain distances in a hemisphere around the source, in accordance with a specified standard, often undertaken in specially designed chambers.

Ambient, specific, residual & background

The ambient noise level is the total noise level at a location, and thus describes the overall noise level due to all sources audible at that location. The ambient level is affected by the source under consideration, as well as traffic, birdsong, passing insects, aircraft, distant sources, etc. These other sources are termed 'extraneous'.

The $L_{Aeq\ T}$ level measured over interval T will be affected by all sounds present during that interval. Some of these will influence the $L_{Aeq\ T}$ value more than others. A passing truck will affect the result more than a passing car. Two passing trucks will contribute more than one passing truck. Birdsong may be significant if close to the measurement location. The source under consideration (e.g. a quarry) may not particularly influence the measured $L_{Aeq\ T}$ value at all. If the quarry is only slightly audible, or inaudible, the recorded $L_{Aeq\ T}$ value will be entirely unrepresentative of the quarry noise level. Even if the quarry is clearly audible, intrusion from other sources such as local traffic may render the $L_{Aeq\ T}$ value unrepresentative of the quarry. A single loud event, or an event close to the microphone, may be enough to render the $L_{Aeq\ T}$ value unrepresentative.

This is an important point. A Local Authority Officer may be tempted to compare measured $L_{Aeq\ T}$ levels to a limit specified by a planning noise condition. But if the $L_{Aeq\ T}$ value is not representative of the source under consideration, this comparison is meaningless. The quarry operator or factory manager is not responsible for noise emissions generated by passing cars, aircraft and other extraneous sources.

The $L_{Aeq\ T}$ level reported by the sound level meter describes the **ambient** level. $L_{Aeq\ T}$ levels presented in most noise reports describe the ambient level at each measurement position, and NOT the level due specifically to the source under consideration. The **specific** noise level, or specific $L_{Aeq\ T}$, describes the noise level attributable solely to the source under consideration. It is a measure of the sound pressure level specifically emitted by the source, impacting at the measurement position over time interval T.

Sound level meters are by themselves incapable of identifying the specific sound pressure level. At a particular position, affected by a variety of noise sources, the sound level meter is unable to separate out the contribution specifically attributable to the facility under consideration. The calculation of this contribution is a matter for the person interpreting the results, and is best done by the survey operator in the field.

Calculation may be done in a number of ways. The survey operator may subjectively estimate the proportion of the ambient noise which is due to the source under consideration. The operator may measure closer to the site boundary, where source emissions are clearly audible, and calculate the level at the position of interest. The operator may measure the ambient noise level when other extraneous sources have

reduced, for example during the evening. Statistical values of the ambient noise level are often used. For instance, a steady source in an otherwise fluctuating noise environment may be readily described using the $L_{AF90\ T}$ value. This is an entirely acceptable practice, designed to accurately describe the noise impact of a specific source, and not (as has been misinterpreted in the past) as a means of affording some benefit to the source operator. Regardless of method used, any noise report should clearly indicate the method applied.

The ambient level minus the specific level is the **residual** level. This is the noise level prevailing when the source under consideration is inaudible or absent, or does not contribute to the noise environment because it is too low, or because extraneous sources are too high. The residual $L_{Aeq\ T}$ is the sound pressure level due to all sources except the source under consideration. This value may be useful in calculating the specific $L_{Aeq\ T}$. On occasion, the specific $L_{Aeq\ T}$ attributable to the source in question may be simply determined by subtracting the residual $L_{Aeq\ T}$ from the ambient $L_{Aeq\ T}$.

The term **background** noise level is commonly used in assessments, not always correctly. The background noise level is often, incorrectly, assumed to be the residual $L_{Aeq\ T}$ i.e. the $L_{Aeq\ T}$ value measured when the source under consideration is shut down or does not contribute. On new projects, the $L_{Aeq\ T}$ level measured prior to construction of the development is often assumed to represent the background noise level. This is not correct. The $L_{Aeq\ T}$ level measured prior to its construction represents the residual $L_{Aeq\ T}$ value, and NOT the background level.

The background noise level is, in fact, the $L_{AF90\ T}$ value of the residual measurement. Thus the background level is the noise level exceeded 90 % of the time during a measurement recorded in the absence of the source. The reason for the differentiation is that the residual $L_{Aeq\ T}$ will be affected by all extraneous sources present during the survey, including passing traffic, birdsong, aircraft, a contractor trimming a hedge nearby, a farmer spreading slurry, a dog barking at the survey operator, etc. While some of these sources arguably form part of the background noise environment, it is unreasonable to include unusual or transient sources. Use of the $L_{AF90\ T}$ value minimises the impact of such transient sources. Thus the background noise environment may be more fairly represented by the residual $L_{AF90\ T}$ value, and not the residual $L_{Aeq\ T}$ value. The difference between these values may be 10 dB or more during the daytime.

The importance of this distinction may be seen in the following example. A noise assessment shows that a proposed manufacturing facility will give rise to a specific $L_{Aeq\ 15\ min}$ level of 49 dB at a receptor. The existing residual $L_{Aeq\ 15\ min}$ level measured prior to construction of the factory is 48 dB. The existing residual $L_{AF90\ 15\ min}$ level is 42 dB. Impacts are often assessed by comparison with existing noise levels. A comparison with the residual $L_{Aeq\ 15\ min}$ level shows an increase of 1 dB, which is marginal. In contrast, a comparison with the residual $L_{AF90\ 15\ min}$ level shows an increase of 7 dB, which is more significant. The severity of the impact on local residents may be more fairly represented by the 7 dB increase than the 1 dB increase.

A robust noise assessment will usually assess impacts by reference to the background noise level i.e. residual $L_{AF90\ T}$. While *Guidelines for environmental noise impact assessment* (Institute of Environmental Management & Assessment, 2014) notes that it

may be appropriate to use other indicators to describe the baseline noise environment in some cases, experience indicates that the $L_{AF90\ T}$ is usually the most appropriate descriptor. It may also be useful to assess impacts by comparing the increase in $L_{Aeq\ T}$ levels with and without the proposed development. The Local Authority Officer should seek to ensure that indicators used to describe the background and/or baseline conditions are appropriate.

Additional comments on specific levels & assessment of compliance

Most environmental noise reports, particularly those prepared for planning compliance, refer solely to the ambient noise level. Determination of the specific level is often ignored, or may be loosely discussed in the text. For instance, a report may state 'the noise level at the measurement position was 57 dB, but this was mostly due to traffic, and the factory is likely to have been lower than the 55 dB limit'. Such wording represents a vague attempt at separating out the ambient and specific noise levels. It is preferable that the procedure is more clearly set out, and that levels discussed in the text are clearly identified as ambient or specific. In most cases, noise limits should be assessed in light of specific levels, and NOT ambient levels.

It is important to highlight that in most cases it will not be appropriate to directly compare measured ambient noise levels ($L_{Aeq\ T}$) with planning permission or licence limits, particularly where significant extraneous noise has been identified by the assessor. In such cases, it can be misleading, inappropriate and unacceptable to compare measured $L_{Aeq\ T}$ results with noise limits applicable to the specific source, as such results will describe ambient levels, and will therefore be contaminated by extraneous noise.

The $L_{AF90\ T}$ may be more appropriate if the source emits a steady noise. The reason and/or justification for using the $L_{AF90\ T}$ level to describe specific noise emissions should be noted in the report and in the assessor's measurement observations. The justification for using the $L_{AF90\ T}$ level is normally established during the survey, and involves the application of acoustic expertise along with knowledge of the facility and the locality. During a survey, comparison of instantaneous noise with other noise indices may make it clearly apparent that (in some instances) the $L_{Aeq\ T}$ has the potential to misrepresent the noise level attributable to the specific source. A professional judgement needs to be made whether it is reasonable to directly compare the measured $L_{Aeq\ T}$ level with the specified licence or planning permission limits in situations where it is obvious that they have been affected by extraneous noise.

The key to understanding this issue relates to the fact that the limit value for noise should normally apply to 'noise from the specific facility or installation', and in some circumstances this may be best described using the $L_{AF90\ T}$ value and/or shortened measurements. Regardless of method used, any noise report should clearly indicate the method applied. It should not be acceptable to claim that, due to extraneous noise, a judgement or assessment of compliance could not be made, although it may suffice to conclude that specific levels are lower than the relevant limit on the basis that total $L_{Aeq\ T}$ levels are lower than the limit, without determining the actual contribution

attributable to the facility in question. The competence of the assessor will usually be critical to the outcome here.

Frequency spectra

A sound level meter which measures the ambient noise level at a location will present the result as a single value, usually the $L_{Aeq\ T}$. A modern meter will typically measure the sound pressure level across a wide range of frequencies, and sum the results to calculate the $L_{Aeq\ T}$ value. This mimics the human ear, which does not simply hear one overall $L_{Aeq\ T}$ level, but instead hears noise emissions across the frequency spectrum, from 20 Hz up towards 20,000 Hertz (Hz).

Noise emissions at lower frequencies, below 100 Hz, are emitted by 'deep' sounds, such as a hum from a generator, the throb of a truck, low bass from amplified music, or the deep drone of a distant foghorn. Frequencies above 1000 Hz consist of whistles, whines and screeches, such as those from birdsong and squeaking bearings in machinery. Most sounds in the typical human environment (offices, conversation, outside, etc.) occur in the range 100-1000 Hz.

A sound level meter will usually measure noise levels across these frequencies, and add them up to generate the $L_{Aeq\ T}$ value. It is during this summing up procedure that the A-weighting discussed above is factored in, to mimic the response of the ear.

To measure sound levels at each individual frequency, a sound level meter measuring noise levels eight times each second (using the fast time function) would be required to measure almost 20,000 individual frequency levels in the range 20-20,0000 Hz. This is a tall order for any instrument, and would produce masses of data with no appreciable benefit. Even logging the highest level only once each second would still produce huge volumes of data, particularly over an interval of 30 or 60 minutes. Thankfully, a simplified procedure was devised decades ago, whereby the 20-20,000 Hz range is divided into bands, termed octave bands. The bands are not of equal width, but instead widen as they move up the spectrum, as this reflects how the ear hears. The bands are standardised internationally. Figure 6 over shows noise levels from a typical environmental measurement, divided into octave bands.

The octave bands shown in Figure 6 are typically used for noise modelling. While an overall A-weighted level can be used to form the basis of a predictive model, the accuracy of such an approach is reduced due to the varying effects of atmospheric absorption and ground attenuation in different bands. Accuracy is enhanced by modelling each band separately, and then summing the predicted levels in each band to calculate the received A-weighted level, the $L_{Aeq\ T}$. In practice, modelling is usually confined to the bands 31.5, 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz.

For most compliance and nuisance investigation surveys, analysis of the octave bands described above will not yield sufficient detail. It is conventional practice therefore to divide each octave into three sub-bands, called one third octave bands. Figure 7 shows a typical one third octave band spectrum. The source assessed here is the same as that shown in Figure 6, but in this case measured in third octave bands.

Figure 6: Sample of a frequency spectrum, assessed in octave bands. This particular measurement was recorded over 15 minutes, and thus the noise level in each band is the $L_{Zeq\ 15\ min}$ level rather than $L_{Aeq\ 15\ min}$ level.

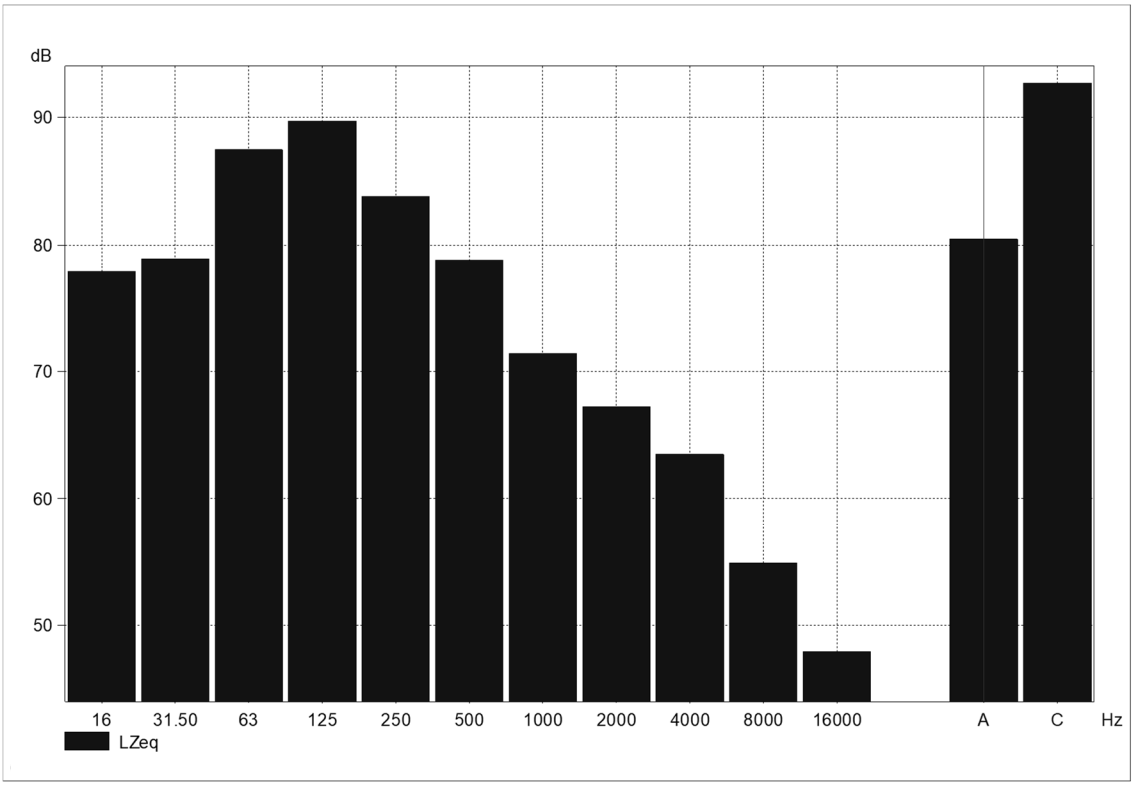
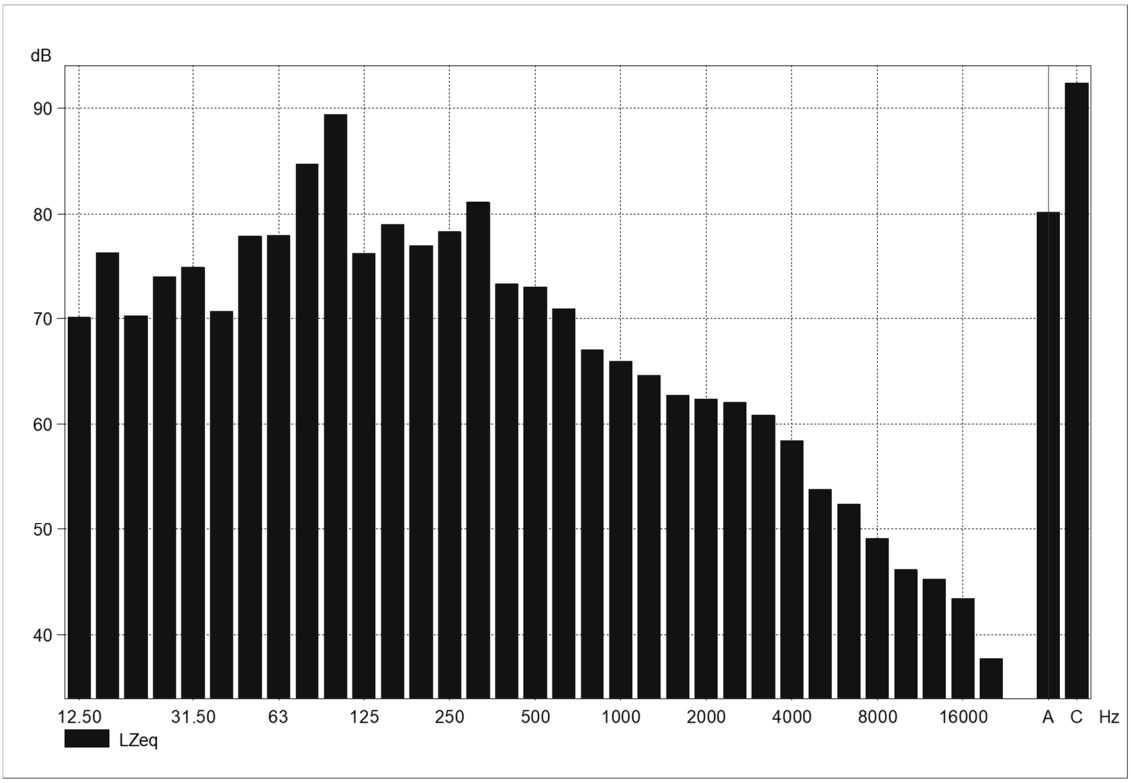


Figure 7: Frequency spectrum from Figure 6, represented in one third octave bands. The overall $L_{Aeq\ 15\ min}$ level is the same as before, calculated by summing the $L_{Zeq\ 15\ min}$ levels across the one third octave bands.



Where greater detail is required, it is possible to analyse spectra using techniques with greater resolution. Such techniques include 1/12 octave band analysis and narrow band analysis based on FFT (fast Fourier transform). Such techniques are typically only required for identification of problematic tones. Their use is gradually becoming more common, due to their reference in an increasing number of standards.

With respect to frequency spectra graphs such as those shown in Figures 6 and 7, conventional practice is to apply the A-weighting correction only when summing the bands to calculate the overall A-weighted $L_{Aeq\ T}$ value. The $L_{Aeq\ T}$ value in Figures 6 and 7 is shown on the right hand side of the plots, measuring 80 dB. Also shown is the C-weighted value (the $L_{Ceq\ T}$). The $L_{Ceq\ T}$ value is not usually required in environmental noise measurements, and may be ignored.

Because the A-weighting is applied only when calculating the overall $L_{Aeq\ T}$ value, the $L_{eq\ T}$ level measured within each band is not A-weighted. The individual unweighted $L_{eq\ T}$ values were historically termed 'linear' values. In recent years, the linear factor has been replaced by the 'Z-weighting'. The result is more or less the same i.e. the Z-weighted $L_{eq\ T}$ value in each band indicates that no A-weighting has been applied to the band. The Z-weighted noise level in each band is termed the $L_{Zeq\ T}$ value. On occasion, a noise report may refer to $L_{Aeq\ T}$ levels in individual bands, and may show a spectrum where each band is shown with the A-weighting applied. The reason for showing an $L_{Aeq\ T}$ spectrum rather than an $L_{Zeq\ T}$ spectrum should be clearly set out. The importance of this distinction is relevant to the assessment of tones, as discussed below.

Figures 8 and 9 over show $L_{Zeq\ T}$ and $L_{Aeq\ T}$ spectra for the same measurement. A considerable difference is apparent. It is therefore important that a noise report clearly states which is applied. This also applies to tabulated frequency data (some reports may include frequency data in tables as well as graphs).

Tones

A noise source which emits a reasonably even amount of acoustic energy across the spectrum is termed a broadband source. An example of a broadband source is an air management system at a facility which gives rise to a 'whoosh' sound rather than a whine or hum. Listeners tend to be much more tolerant of broadband sources than those which are not broadband.

Some sources may generate emissions which predominate in one or more octave bands. The source shown in Figure 6 above clearly gives rise to greater emissions in the 63 and 125 Hz bands. Figure 7, which shows the emissions as third octave bands, and thus in more detail, indicates that most of this energy is emitted in the 100 Hz third octave band, with some additional energy in the 16 Hz, 80 Hz and 315 Hz third octave bands. Such detail cannot be gleaned from merely reporting the overall $L_{Aeq\ T}$ level only.

Figure 8: Typical frequency spectrum showing $L_{Zeq\ T}$ levels in each third octave band.

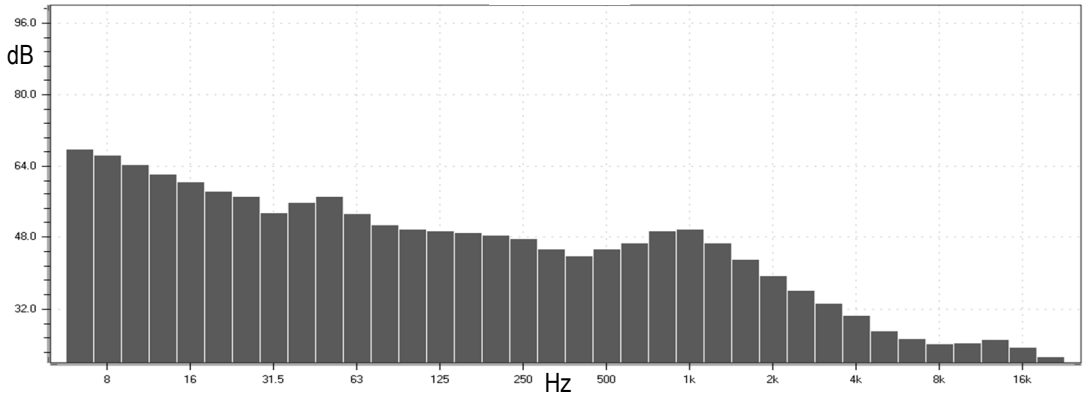
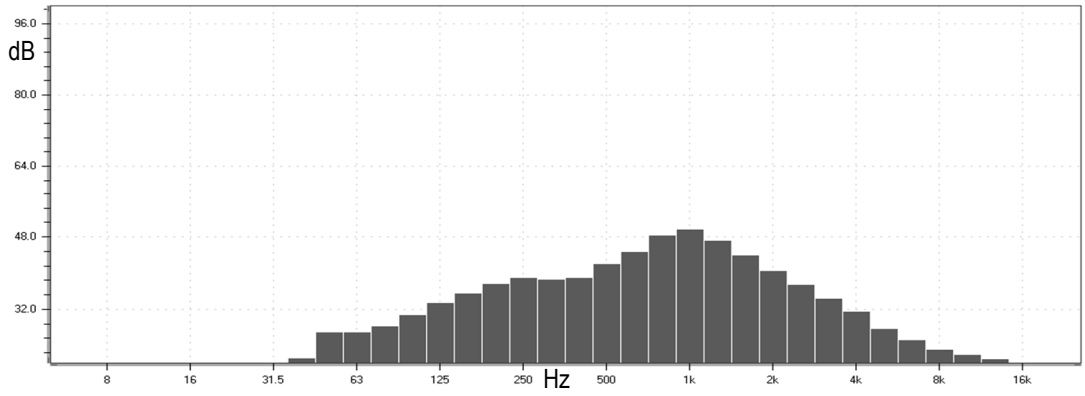


Figure 9: Same spectrum, with A-weighting applied to each third octave band ($L_{Aeq\ T}$).



In certain cases, a relatively large proportion of the acoustic energy generated by a source will be emitted in a single octave band, or in a single third octave band. This will be visible in the frequency spectrum as a spike in one band. When assessing such emissions, third octave band analysis is usually undertaken rather than octave band analysis, thus providing greater detail.

A source which generates a spectrum with a spike in one or more third octave bands may be potentially perceived as ‘tonal’. A tonal noise is that which contains a clearly audible tone, i.e. a distinguishable, discrete or continuous note (whine, hiss, screech or hum, etc.) and is typically characterised by a concentration of energy at one or two frequencies. A tonal source is usually found to be more annoying than a broadband source at the same volume.

The tonal energy may occur on the left hand side of the spectrum, in the lower frequencies (e.g. generators typically give rise to increased energy in the 80 Hz third octave band). The energy may be found in the middle of the spectrum (e.g. some fans may give rise to elevated energy in the 200-500 Hz range). Or it may be found on the right hand side of the spectrum (e.g. spikes in the 2,000-8,000 Hz range are often attributable to birdsong).

In many cases, a spike in one particular third octave band may be prominent, but the source may not be deemed audibly tonal by the listener. Various objective methods are used to determine at what level of prominence a spike becomes significant and/or audibly tonal. The most commonly used method is to compare the third octave band

spike to its immediate neighbours. In Figure 7 above, this involves comparing the $L_{Zeq\ 15\ min}$ level in the 100 Hz third octave band to the $L_{Zeq\ 15\ min}$ levels in the 80 Hz and 125 Hz bands, which lie to its left and right respectively. The source is deemed tonal if the level in the 100 Hz band exceeds BOTH neighbours by 15 dB. In Figure 7, the differences are 5 dB (on its left) and 13 dB (on its right). The source in question is therefore not tonal. This also applies to the 16 Hz third octave band, which protrudes above its immediate neighbours by 6 dB.

The 15 dB prominence factor is not applied all the way up the spectrum. In order to mimic the way the ear hears tones, the factor reduces with increasing Hz. Between 160 and 400 Hz inclusive, the prominence factor reduces to 8 dB on both sides. Above 400 Hz, a signal will be deemed tonal if a spiking third octave band exceeds both neighbours by 5 dB. In Figure 7, a slight prominence in the 315 Hz third octave band does not exceed its immediate neighbours by 8 dB, and therefore the signal is again not deemed tonal.

As noted previously, more detailed investigative techniques such as FFT may be required in certain cases if the presence of audible tones is in dispute and/or third octave band data are deemed insufficient.

Where tones are confirmed to be present, several standards recommend that a penalty be added to the specific $L_{Aeq\ T}$ level. The corrected level is often termed the 'rating level', and denoted the $L_{Ar\ T}$ level by the EPA.

While a tone may be detected by sound measurement equipment and software, the tone may not be of audible significance, and the noise assessor will be required to use judgement to confirm if a tone is audibly significant or not. A tone in a particular third octave band may be below the hearing threshold in that band i.e. it may be lower than the typical threshold of human hearing and may therefore not be audible. This may particularly be the case at lower frequencies. A 2011 UK DEFRA report (see references) states that a tone will not be inaudible internally in a dwelling if the $L_{Zeq\ T}$ level in the third octave band of relevance is less than the corresponding threshold value shown in Table 1.

Table 1: Hearing threshold values in the 10-160 Hz bands. A tone detected in, say, the 40 Hz band, and which measures 44 dB, will be inaudible, and therefore not of audible significance. A penalty is therefore not applicable. Note that these criteria apply only to internal measurements.

Band Hz)	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**
L_{Zeq} (dB)	92	87	83	74	64	56	49	43	42	40	38	36	34

It is reiterated here that, just because software detects a tone, it does not automatically mean that a tone of audible significance exists. This is particularly relevant to unattended surveys and/or surveys where data are subjected to an automated assessment procedure. Because tone assessment also incorporates a subjective element, it should be overseen by a suitably qualified person with experience in this area.

Impulses

As discussed above, the presence of one or more tones in a noise signal will render the emissions more annoying to most listeners. Tones are not the only features which may potentially increase annoyance. Other features include impulsivity, intermittency and other time-varying characteristics. The most recognisable of these features is impulsivity. An impulsive noise is a short duration spike, typically less than one second in duration, where the instantaneous noise level suddenly rises and falls. Impulsive sources include bangs and metal clangs. An impulsive source may be a single discrete event (e.g. a shotgun blast or 'crow banger') or a repetitive event (e.g. a pile driver).

An impulsive noise is generally considered to be more annoying, and indeed is often considered to be more annoying than a tonal source. Like tonal noise, several standards recommend the addition of a penalty to the specific $L_{Aeq\ T}$ level where a source is impulsive. As before, the corrected level is termed the rating level. At least one standard allows the addition of two penalties where a source is tonal AND impulsive.

The assessment of tonal noise benefits from objective analysis methods such as one third octave band analysis. While objective methods are also available with respect to impulsive noise (e.g. *British Standard BS 4142:2014 Methods for rating and assessing industrial and commercial sound* (2014)) the methods are less widely used due to (a) the requirement for sound level meters to measure noise levels at extremely fast speeds (down to 10 ms), a feature which is still not available on all meters, and (b) the high possibility of false positive results. Standards, techniques and equipment are improving continuously, and in the coming years objective impulsivity tests are likely to become de riguer. In the meantime, impulsivity is commonly assessed by subjective listening. This method has proved to be effective to date, as impulsivity is typically instantly recognisable and unlikely to be disputed. Subjective assessment of impulsivity is therefore likely to remain acceptable into the future, and indeed it is considered that impulsivity should be subjectively assessed in the first instance. Objective methods may be used subsequently if there is any disagreement in the outcome of the subjective assessment.

As with tonal assessment, any assessment of impulsivity will rely on subjective judgement, and therefore should be undertaken by a suitably qualified acoustician with relevant experience.

3. Measurement

Guidance

Many Local Authority Officers have access to one or more sound level meters that can be used to assess compliance with planning noise limits and to investigate complaints. Other authorities prefer to contract such work out to independent assessors. Regardless of policy, surveys should be carried out to a recognised standard. The measurement standard most commonly applied to environmental noise surveys is International Standard ISO 1996. The standard consists of two parts:

- *ISO 1996-1:2016 Acoustics – Description, measurement and assessment of environmental noise, Part 1: Basic quantities and assessment procedures* (2016).
- *ISO 1996-2:2017 Acoustics – Description, measurement and assessment of environmental noise, Part 2: Determination of environmental noise levels* (2017).

In drafting noise conditions for inclusion in planning permission, many Local Authority Officers regularly request that compliance surveys be undertaken in accordance with *ISO Recommendation R 1996: Assessment of noise with respect to community response*, or *ISO Recommendation R 1996/1, 2 and 3: Description and measurement of environmental noise*. These are earlier versions of the ISO 1996 standard, which have been revised and replaced several times. With a view to adopting the most up to date guidance, it is advisable that Local Authority Officers request that surveys be done to the latest edition.

Useful guidance is additionally included in EPA document *NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities* (2016), which is freely available at www.epa.ie.

Practice

Whether a Local Authority Officer is carrying out a noise survey directly, or whether the Officer is reviewing a report prepared by a noise assessor, attention should be particularly paid to the following:

- Competence. This is discussed in Section 4.
- Measurement position. To avoid reflection from nearby surfaces, measurements should be made in free field conditions. This may be achieved by setting up the microphone at least 3.5 m from walls or other surfaces, other than the ground. In some cases, such a separation distance is not possible (e.g. for reasons of access or safety). On occasion, measurement at the façade of a dwelling may be required (usually undertaken 1 m from the façade). Where measurements are not recorded in free field conditions, this should be clearly indicated in the report. A correction may be applied to the measured level to account for the presence of a nearby wall or other structure. Where the

microphone is positioned within 0.5 m to 2 m of a wall, ISO 1996-2:2017 states that a correction of 3 dB is generally applicable depending on position and source type (i.e. the difference between the level recorded with the wall in place, and the level recorded if the wall was not there, is 3 dB). Other corrections will apply if the microphone lies close to a corner. Any such corrections should be clearly outlined in the report.

- Microphone height. Microphones are typically positioned 1.2 m to 1.5 m above ground level. Higher positions may be warranted when assessing noise levels at certain positions, such as levels affecting upper floors. A height of 4 m is often used when assessing impacts at first floor level.
- Windscreen. Environmental measurements should never be undertaken without a foam windscreen in place over the microphone, to minimise breeze effects. The standard windscreen diameter is 90 mm. Anything less than this merely constitutes a dust cover, and is unsuitable for environmental noise measurement. Many sound level meters are used with dedicated outdoor microphone kits which provide protection from weather. All such kits benefit from foam windscreens of minimum diameter 90 mm. Use of a second outer windscreen has become standard practice in windfarm measurements.
- Measurement interval. The time interval T will usually be dictated by the noise limit being assessed, or by the standard being followed. Typical intervals are 15 minutes, 30 minutes and one hour. A survey may be undertaken over an extended period, either attended or unattended, and the relevant intervals may be subsequently extracted using noise software.
- Weather. The propagation of noise is influenced by atmospheric conditions and precipitation. Consequently, the presentation of noise data in a report is meaningless without inclusion of details of weather conditions prevailing at the time of the survey. Surveys may be undertaken at any ambient temperature, as most microphones have a reasonably wide tolerance level. Temperature and cloud cover should always be noted in a noise report.
- Precipitation. Rainfall may affect data in three ways: (a) ambient noise levels may be raised due to rain falling on the ground, due to increased flow in nearby streams, and due to altered traffic noise, (b) rain falling on the microphone windscreen will generate spurious noise, and (c) prolonged rainfall may ultimately damage the microphone and sound level meter unless the equipment incorporates specific protection. ISO 1996-2:2017 notes that measurements recorded during rainfall should be discarded unless it can be shown that the effect has been negligible. In practice, any precipitation other than a light mist is likely to invalidate results. Precipitation conditions should always be included in a report.
- Fog. The presence of fog may be indicative of a temperature inversion, which may significantly alter noise propagation, and thus fog is also likely to invalidate results.
- Wind. Even with a microphone windscreen in place, wind is likely to generate noise effects as it passes over the microphone. Elevated wind will also increase ambient noise levels due to rustling vegetation, wind through overhead wires, etc. In an ideal world, noise surveys would be undertaken during calm conditions, or with a light breeze blowing from source to receiver (termed a ‘positive wind component’, or ‘favourable propagation conditions’). However,

this is not practical in a windy country such as Ireland, and an upper wind speed limit of 5 m/s is usually acceptable. In their 2016 noise guidance document, the EPA notes that the average wind speed should be less than 5 m/s during a survey, although occasional gusts to 7 m/s are acceptable. Wind speed is typically measured at intervals by the survey operator using a handheld anemometer. Wind speed quoted from a distant weather station is unacceptable, unless the station lies in reasonable proximity (and even then, such data should be treated with caution, as local conditions may vary considerably). Wind direction should always be included in the report. Where the purpose of a survey is to investigate alleged annoyance, the survey should ideally coincide with favourable propagation conditions.

- Sound level meter type. Sound level meters are divided into two types: Class 1 and Class 2, as defined by standard IEC 61672-1:2013. Class 1 meters are more accurate than Class 2. All environmental noise surveys should be undertaken using the former. Most meters used by noise assessors meet Class 1 specifications. However, this should always be confirmed in the noise report. Under no circumstances should data from an instrument which has not been type approved under IEC 61672-1:2013 be accepted. Such instruments include mobile phones, and equipment assembled from separately sourced parts.
- Laboratory calibration. Sound level meters are typically returned to the manufacturer or to an independent laboratory at intervals to be compliance tested. This ensures that the entire measurement chain, from microphone to meter, meets the requirements of IEC measurement standards. Several manufacturers recommend that this is undertaken annually. However, most standards allow an interval of up to two years. The field calibrator should, in contrast, be calibrated annually. Calibration certificates may be included in the noise report, or at the very least should be available on request.
- Field calibration. To ensure that the sound level meter and microphone are operating satisfactorily, they should be calibrated at the start of each survey using a field calibrator. The calibrator, when placed over the microphone, emits a steady signal at a specified volume and frequency, which the sound level meter uses to form its baseline. This procedure is undertaken because meters may drift slightly from time to time, depending on atmospheric and microphone conditions. Prior to field calibration, it may be necessary to allow several minutes for the microphone to acclimatise, particularly if removed from a case in a warm car. The time of the calibration, the meter sensitivity, and the calibrator used should always be noted in the noise report.
- Drift. At the end of the survey, the calibrator should again be placed on the microphone, and the $L_{Aeq\ T}$ level displayed on the sound level meter screen should be recorded and noted in the report. The purpose of this final check is to determine meter drift, if any, during the survey. A drift of up to 0.5 dB is generally acceptable. A larger drift will invalidate results recorded during that survey.
- Uncertainty. All measurements are subject to some degree of uncertainty, due to tolerances in the measurement equipment, atmospheric conditions, microphone position, source conditions, etc. It has become standard practice to include a statement of uncertainty in noise reports. It is generally beyond the remit of most reports to definitively calculate the magnitude of uncertainty.

However, at the very least, the degree of uncertainty may be loosely qualified as low, medium or high.

Unattended monitoring

An additional comment is warranted here in relation to unattended monitoring. Traditionally, most surveys are attended i.e. the survey operator is present throughout. This facilitates a meaningful interpretation of recorded data. A survey should generally be attended where (a) there may possibly be a subsequent dispute e.g. there is an alleged noise nuisance, or (b) there may be doubt as to the magnitude of various contributing sources to measured levels.

Unattended monitoring is typically used for certain surveys that need to be carried out over extended periods. In their NG4 document, the EPA notes that unattended monitoring may be undertaken at a position close to a facility boundary where facility emissions entirely dominate.

A useful feature available in some sound level meters is audio capture, which allows recording of audio files which can be played back later using suitable equipment and appropriate software. This feature allows unattended monitoring to be undertaken in an increasingly wide range of applications. On analysing recorded sound level data, the survey operator may play back the corresponding audio file with respect to any period of interest.

The advantages of unattended monitoring, where suitable, are clear. Unattended monitoring may allow surveys to continue for longer periods than previously possible. Where a source occurs sporadically, it may not be practical for the survey operator to wait for its occurrence. Unattended monitoring with audio capture is useful here, particularly in investigative surveys. Unattended monitoring with two or more sound level meters may allow a larger number of positions or intervals to be monitored during any one survey.

Notwithstanding the practical benefits of unattended monitoring with audio capture, certain precautions continue to apply. Audio file playback, while useful in identifying sources, is of limited use in actually determining the contribution attributable to each source (unless one source entirely dominates, in which case measured levels will represent that source). In addition, playback through speakers is unlikely to faithfully reproduce all of the acoustic features associated with a source which contribute to its impact on the soundscape. In other words, the nuance of the situation may be lost. Where tones, impulses or other features are present or are alleged, the absence of a competent survey operator in an unattended survey precludes the possibility of further clarification.

This is of particular relevance to legal and/or potentially controversial cases. As noise data used in these cases may be disputed, it is important that such data are measured during attended surveys, overseen and witnessed by a qualified assessor. However, data may be supplemented with unattended survey data where appropriate.

Where unattended monitoring is undertaken, it will be necessary to record local weather conditions, preferably through use of a temporary weather station.

In summary, unattended monitoring with audio capture is a realistic and practical option in some scenarios. Where unattended monitoring is carried out, the survey operator should be familiar with the measurement position and its soundscape, to allow a valid interpretation of measured data, and supported by audio playback. Definitive conclusions made on the basis of unattended monitoring may not be possible in all cases.

A survey checklist has been prepared by the AACI, and is presented in an appendix to this document.

4. Competence

Sound measurement and evaluation of noise is a complicated issue. The days of simply holding up a sound level meter and reading results on the display are long gone. EPA document *NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities* (2016) notes that, to be competent, an operator needs to possess 'a combination of technical knowledge, experience and skills', and sets out a list of minimum requirements. The AACI recommends a similar list of requirements before an operator may be deemed competent.

Competence applies to the full range of noise functions undertaken by any person. Thus it applies to noise measurement during surveys, sound level meter use, subsequent data analysis, assessment of compliance with limits, assessment of impacts, predictive modelling, knowledge of relevant criteria and standards, reviewing noise reports, and so on.

All competent persons must possess a combination of technical knowledge, experience and skills, and must be able to demonstrate, as a minimum:

- An in-depth comprehension of relevant acoustic standards.
- Familiarity with acoustic measurement equipment.
- Knowledge of relevant noise indices.
- Familiarity with relevant analysis and modelling acoustic software.
- Familiarity with tone and impulse analysis.
- An ability to analyse, interpret and explain results in a concise formal report.

Also important are:

- Relevant qualifications.
- Membership of a professional or trade body (e.g. the Institute of Acoustics, the Association of Acoustic Consultants of Ireland, etc.).
- Commitment to continuing professional development (CPD).

It is worth noting here that it is possible for an individual to possess membership of a particular body, yet have little experience in that specific noise topic. For instance, an MIOA (Member of Institute of Acoustics) status granted through a qualification in music does not render the holder an expert in environmental noise assessment. While such a member may at first glance appear to be as qualified as other MIOAs, the member is unlikely to be sufficiently knowledgeable on environmental noise. Certain acoustic assessors may be qualified through specialist dissertation not relevant to the work at hand.

Professional and trade bodies such as the IOA and AACI require their members to adhere to a strict code of conduct. One of the core tenets of such codes is that members do not work outside their area of competence.

Local Authorities should ensure that personnel directly involved in measuring noise meet relevant competency criteria including specific training and qualifications. Noise reports prepared by assessors should include a statement of competence including

relevant qualifications and training. Caution may be warranted with respect to any noise report which does not clearly indicate the competence of the author and/or those who undertook monitoring and subsequent data interpretation.

Noise reports submitted to Local Authorities should include information about the report author, and details specific to the project and assessment method. Information which should be provided in impact assessment reports is set out in Section 7.

PART 2:

GENERAL GUIDANCE FOR LOCAL AUTHORITY OFFICERS

5. Legislation

Planning legislation

Apart from a number of specific exceptions, there are no national mandatory noise limits in force in Ireland, and no obligatory sector-specific limits. The exceptions relate chiefly to (a) those referenced in the Planning and Development Regulations 2008 (S.I. No. 235/2008) which specifies a 43 dB noise limit in relation to small scale energy production sources such as boilers, wind turbines, heat pumps and CHP plants, and (b) by-laws issued in relation to busking.

Most facilities are regulated either by the EPA, through licences, or by Local Authorities, through planning permission and permits. Where limits attached to such consents have been proven to be breached, the EPA may initiate legal action through the EPA Act 1992, while a Local Authority may use the Planning & Development Acts 2000-2020 and/or the EPA Act as described below.

EPA Act

The EPA Act 1992 includes three sections which specifically refer to noise, outside of non-compliance with an issued licence. These are:

- Section 106 allows the Minister (specifically the Minister for the Environment) to issue noise regulations in relation to any noise source. To date, no such regulations have been issued.
- Section 107 provides for a Local Authority (or the EPA in relation to a licensable activity) to issue a noise notice to an operator to prevent or limit a noise source.
- Section 108 allows a Local Authority, the EPA or any affected person to take a complaint to the District Court. The Court may order the person or body responsible for the emissions to take measures to prevent or limit the noise.

Section 108 has been widely used to date by both Local Authorities and members of the public. Most judges are unwilling to hear any case that does not benefit from measured noise data. Given the level of competence required in acquiring such data, surveys used to obtain data for S.108 cases are in most cases undertaken by experienced noise assessors. However, a number of Local Authorities employ qualified and experienced in-house personnel to progress such cases. On occasion, unsocial hours associated with investigative surveys may preclude direct intervention by a Local Authority Officer, and a decision may be made to commission an independent assessor.

Environmental Noise Directive

EU Directive 2002/49/EC relating to the assessment and management of environmental noise (the Environmental Noise Directive or 'END') provides a standardised framework for environmental noise planning throughout the EU. The primary aim of the Directive is 'to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise'. This is to be achieved through several methods, one of the chief methods being an obligation on Local Authorities to carry out strategic noise mapping and to prepare noise action plans to prevent and reduce the number of people exposed to elevated noise levels, and to maintain satisfactory soundscapes where present. Action plans are updated at regular intervals, at least every five years. The Directive deals with noise emitted by means of transport (road, rail and air traffic), and from sites of industrial activity including those defined in Annex 1 of Council Directive 96/61/EC concerning integrated pollution prevention and control. The areas and infrastructure must fall within defined criteria such as traffic load before they are included in noise planning.

In 2008, the EU Commission launched the development of the common noise assessment methodological framework through the project 'Common Noise Assessment Methods in the EU' (CNOSSOS-EU) led by its joint research centre. Arising from this, Commission Directive (EU) 2015/996 was published in 2015 and deals with establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council. This Directive amends 2002/49/EC.

Directive 2015/996 is technically detailed, and sets out the common assessment methods (i.e. computation and measurement) used to determine L_{den} and L_{night} levels at assessment positions for the purposes of strategic noise mapping of major transport and industrial sources.

The European Communities (Environmental Noise) Regulations, 2018 (S.I. 549/2018) transpose into Irish law Directive 2002/49/EC as amended by 2015/996, and replace earlier Regulations S.I. 400/2006. The Regulations designate the EPA as the national authority for the purposes of the Regulations. The EPA's role includes supervisory, advisory and coordination functions in relation to noise mapping, action planning and reporting.

Noise action plans, and their associated noise maps which identify areas of elevated noise, are strategic tools, and not specifically designed for the assessment of local noise nuisance. With respect to the assessment of planning applications and the setting of noise limits, the chief requirement here for Local Authority Officers is that such limits are consistent with any objectives set out in the Authority's noise action plan.

L_{den}, L_{night} & strategic noise maps

The index L_{den} is a day-evening-night level which is a composite of L_{day}, $L_{evening}$ and L_{night} levels. It is important to recognise that this is a 24 hour index, and that there is no direct comparison between a stated L_{den} value and a perceived noise level at a moment of time. Therefore one cannot generally use L_{den} values to assess nuisance. The L_{night} is a measure of the A-weighted L_{eq} level over the 8 hour period 2300-0700 h (i.e. the $L_{Aeq\ 8\ h}$ value), and is also known as the night noise indicator.

The Environmental Noise Directive requires noise levels to be assessed from road traffic, railways, major airports and industry. It is not a Directive requirement to assess noise generated by other activities such as construction, sports, leisure activities, concerts and the like.

In the assessment of noise impacts, the L_{den} index is not considered appropriate for the determination of noise change, as the index is a relatively crude 24 h average. The index is normally used solely for annual road traffic, air traffic and rail, and in strategic noise maps.

In strategic noise maps, the height above ground level at which the L_{den} is determined depends on the application, and will typically range from 1.5 to 4 metres. Using AADT (annual average daily traffic) figures, road surfaces, gradients, vehicle speeds, site geometry and topography, noise maps are derived as part of each member state's noise mapping requirements and obligations. Thus L_{den} values are predicted rather than measured, although site measurements may be used to validate results.

With all noise predictions and noise mapping, there are always assumptions and limitations. While strategic noise maps are readily available via many web based public platforms, it is important to consider the use of the data, its accuracy and the reliance on such data and its intended purpose. Agencies such as the EPA, for example, are very clear on the limitations of use and state that the main focus of noise maps is for strategic management of environmental noise, based on a notional annual average day. They should not be seen as representing what may be measured directly at any location within the map.

The EPA has prepared a *Guidance note for noise action planning for the Environmental Noise Regulations*. Initially published in 2006, revised in 2009, and updated in 2018, the document provides practical information, advice and guidance to designated Action Planning Authorities on the development of noise action plans under the Environmental Noise Regulations, and reporting of the plans to the EPA. For more details on the EPAs guidance notes, see http://www.epa.ie/pubs/advice/noisemapping/.

Occupational noise legislation

EU Directive 2003/10/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) (2003) specifies maximum noise levels to which workers may be exposed. The Directive is enabled through the Safety, Health and Welfare at Work (General Application) Regulations 2007 (S.I. No. 299/2007). Such limits, termed occupational noise limits, are not relevant to environmental noise assessment, and occupational noise is the remit of the Health and Safety Authority rather than Local Authorities. Occupational noise criteria (currently 80 dB and 85 dB, and described using the $L_{EX\ 8\ h}$ parameter which is beyond the scope of this document) are not of relevance to environmental noise. Any report which refers to the 80 and/or 85 dB values in an assessment of environmental noise impact should immediately be treated with caution.

6. Standards & guidance

International standards

A number of noise standards and guidance documents have been issued by several authorities. In Section 3, reference is made to ISO 1996 Parts 1 and 2, issued by the International Standards Organisation, and which relate to the measurement of environmental noise. Reference is also been made to standard IEC 61672-1:2013, which relates to the specifications of sound level meters.

The ISO has issued several other standards relating to noise. Only one of these is likely to be of relevance to noise reports assessed by Local Authority Officers: *ISO 9613-2:1996 Acoustics: Attenuation of sound during propagation outdoors, Part 2 General method of calculation* (1996). This standard sets out a procedure whereby noise levels arising from a source can be predicted at receptors. While a number of such prediction standards have been issued by different authorities, ISO 9613-2:1996 is the most widely applied in Europe. Regardless of standard followed, any noise prediction report should clearly indicate which prediction standard has been followed.

World Health Organisation

With respect to noise impacts on the community, the most authoritative guidance is probably that issued by the WHO, which has issued a number of noise guidance documents over the last few decades. Their most widely referenced document is *Guidelines on community noise* (1999) which sets out guideline values considered necessary to protect communities from environmental noise. With respect to residential settings, the document notes that an outdoor $L_{Aeq\ 16\ h}$ level of 55 dB is an indicator of potential for serious annoyance during daytime and evening hours, with 50 dB being an indicator of moderate annoyance. The 55 dB criterion was first suggested by the WHO in their 1980 document *Environmental Health Criteria 12*.

Since 1980, the 55 dB criterion has become the de facto daytime limit applied by most Irish regulatory authorities to commercial and industrial operators, and is typically included in noise conditions attached to planning permission issued by Local Authorities and the EPA. Although the WHO criterion applies to daytime periods of 16 hours, authorities typically specify shorter periods, and thus limits of $L_{Aeq\ 15\ min}$, $L_{Aeq\ 30\ min}$ and $L_{Aeq\ 1\ h}$ are variously applied.

The WHO's 1999 guidance document recommends an external night-time criterion of 45 dB to prevent sleep disturbance. As before, $L_{Aeq\ 15\ min}$, $L_{Aeq\ 30\ min}$ and $L_{Aeq\ 1\ h}$ intervals are variously applied by regulatory authorities, rather than the 8 hour period to which the WHO's 45 dB criterion applies. The document includes a 60 dB L_{AFmax} recommendation with respect to the external night-time environment outside bedroom windows. This parameter is used to describe short sudden events which might not affect the $L_{Aeq\ T}$ parameter.

In future decades, it is possible that the 55 dB daytime and 45 dB night-time criteria drawn from WHO guidance may be lowered to say, 50 dB and 40 dB. Indeed, the WHO document *Night noise guidelines for Europe* (2009) makes reference to a 40 dB ($L_{night,outside}$) criterion. However, it should be noted that the $L_{night,outside}$ describes the long term night-time average measured throughout a whole year, whereas the 45 dB criterion referred to in the 1999 WHO document relates to any particular night. The 40 dB $L_{night,outside}$ will most likely inform wider noise policy objectives, while the 45 dB criterion will continue to inform planning criteria in the medium term.

In 2018, the WHO issued *Environmental noise guidelines for the European region* which updates their earlier recommendations. The 2018 document recommends criteria with respect to transport noise, wind turbine noise, and hearing impacts from leisure activities. Those involved in assessment of transport noise impacts will be expected to be familiar with recommendations set out in the document. Wind farm guidance included in the document is less directly relevant at present, and is instead included to inform wind farm noise policy debate.

The 2018 document does not explicitly consider or update industrial noise and indoor guideline values. Thus any values not covered by the 2018 guidelines (such as industrial noise and commercial/mixed use noise emissions in residential areas) remain as before i.e. the WHO 1999 guidelines for the impact of industrial noise on residential property are still valid.

Environmental Protection Agency

Since its inception, the EPA has produced a series of noise guidance documents, the most detailed being the most recent: *NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities* (2016). NG4 specifically applies to industrial, waste and agricultural sectors regulated by the EPA. However, seeing as the document draws on the widely applied WHO criteria discussed above, there is a convergence between NG4 criteria and those applied by Local Authorities. Moreover, the absence of any other authoritative Irish noise guidance inevitably results in widespread application of NG4 to sectors outside of the EPA's remit.

Reference has already been made to NG4 in Sections 3 and 4. Having been written by an Irish noise consultancy on behalf of the EPA, the document includes particularly practical advice drawn on years of experience. Noise limits recommended in the document are discussed in Section 8 below. The document is freely available at www.epa.ie.

With respect to the assessment of noise impacts, two EPA documents are relevant: *Draft advice notes on current practice in the preparation of environmental impact statements* (2015), and *Draft guidelines on the information to be contained in environmental impact assessment reports* (2017). These set out guidance on the assessment of impacts across a range of disciplines including noise, and provide guidance on the qualification of impacts. A noise assessment is usually required to follow these guidelines when undertaken for inclusion in an Environmental Impact

Assessment Report (EIAR). Even where an EIAR is not required, an assessment will benefit from application of the EPA guidance. An noise impact assessment may also be carried out by reference to the UK Institute of Environmental Management & Assessment document *Guidelines for environmental noise impact assessment* (2014).

British Standards Institution

The BSI regularly updates several noise guidance documents which it has issued in recent decades. Three of their documents which have seen widespread application in Ireland (not always correctly) are summarised below.

BS 4142:2014 Methods for rating and assessing industrial and commercial sound (2014) sets out a procedure which may be used to assess the impact of noise emissions from an existing or proposed development on dwellings. The standard provides for the comparison of specific $L_{Aeq\ T}$ levels with background levels, and provides an indication of impact depending on the difference. Specific levels may be rated to take tonal, impulsive and other characteristics into account (see Table 2). The standard notes that the background noise environment may include existing industrial emissions unrelated to the specific source. Daytime and night-time periods of 0700-2300 h and 2300-0700 h respectively are specified.

Table 2: BS 4142:2014 penalties for subjectively assessed features. Penalties may be accumulated where a source exhibits more than one feature. The standard also includes separate objective tests for tones and impulses.

Feature	**Penalty to be added to specific $L_{Aeq\ T}$ level**
Tonality	2 dB for a tone which is just perceptible, 4 dB where clearly perceptible, and 6 dB where highly perceptible.
Impulsivity	2 dB for an impulse which is just perceptible, 6 dB where clearly perceptible, and 9 dB where highly perceptible.
Intermittency	If identifiable on/off conditions are evident and readily distinctive against the residual environment, a penalty of 3 dB may be applied.
Other	Where features are present that are neither tonal nor impulsive, though otherwise readily distinctive against the residual environment, a penalty of 3 dB may be applied (only where no other corrections have been applied).

BS 4142:2014 notes that a difference between specific and background levels of 10 dB or more is indicative of a significant adverse impact. A difference of 5 dB is indicative of an adverse impact, with lower differences suggesting reduced impacts. The standard states that impact will be increased or reduced depending on local context.

The standard is most often used in investigations of alleged noise nuisance, but is also widely applied in impact assessments. It is important to note that the standard sets out a specific list of instances in which it may be applied, and also lists situations where it should not be applied.

The reference to context in BS 4142:2014 is of particular importance. The document notes that, when making assessments and arriving at decisions, it is essential to place the sound in context. The foreword states:

The significance of impact…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.

Part 11 adds:

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 context in which sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Thus any assessment of impact undertaken using BS 4142:2014 should carefully consider and assess the local context. A 2019 amendment to the standard does not alter the core methodology.

BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 1: Noise (2009) and *Part 2: Vibration* (2009) provide useful guidance with respect to noise sources such as construction sites, quarries, and any other site where mobile plant is used. The standard includes guidance for the operators of such sites, and sets out a prediction method suitable for such sources. Being less prescriptive that the prediction method set out in ISO 9613-2:1996, the standard is often used where detailed modelling using the latter would prove superfluous.

Perhaps the most useful feature of BS 5228:2009 is the extensive list of typical plant noise data which was compiled previously through a UK Government funded project. Thus a noise assessor attempting to predict noise emissions from a proposed site, where there are no noise emission details available, may obtain typical details in the standard. Most of the sources listed are mobile machinery found in quarries and construction sites. Assessments of construction phase impacts, and impacts from quarries, are typically undertaken entirely using BS 5228:2009 guidance. A 2014 amendment to the standard makes minor edits to parts 1 and 2. The amended version is termed British Standard BS 5228:2009+A1:2014.

Although not an environmental noise standard, *BS 8233:2014 Guidance on sound insulation and noise reduction for buildings* (2014) is occasionally referenced in noise impact assessments due to its inclusion of recommendations for internal noise levels. The standard is not directly applicable to the assessment of impacts from external sources on building occupants. However, the standard lists internal noise criteria to facilitate use and enjoyment of certain building types, and these criteria are useful in providing a reference. The standard includes recommendations for internal noise levels in living rooms and bedrooms. Such recommendations are occasionally quoted by assessors in assessing impacts. The recommendations are seeing increasing use in

recent years in the assessment of inward impacts on residential development (see Section 26).

The AACI has consulted with the National Standards Authority of Ireland (NSAI) on the continued application of BSI standards following the UK's departure from the EU. The AACI understands that the NSAI's view is that BSI standards continue to be functional and available for reference. The AACI supports this view, and its members are likely to continue applying BSI standards where appropriate.

Other guidance

Several sources benefit from sector-specific guidance, including shooting ranges, amplified music and wind farms. Such guidance is identified in Part 3.

A number of guidance documents have been produced with respect to a range of more obscure sources. These include ice cream van chimes, model aircraft and motorsport. Most of these have been developed in the UK, usually driven by Local Authorities which have been subjected to a barrage of complaints relating to the sources in question.

7. Impact assessment

During the planning application process, certain developments will require preparation of an Environmental Impact Assessment Report (EIAR). A Local Authority may also request an EIAR where one is not automatically required. With respect to smaller developments, an Authority may request that an environmental report is submitted, which focusses on specific issues such as water, visual impacts, or noise. On occasion, a standalone noise impact assessment report may be requested.

Whether specifically required through an EIAR or not, many developments which may potentially give rise to offsite noise impacts will be subject to a noise assessment process. The level of detail may vary. A noise assessment which forms part of an EIAR process is likely to be more detailed and more extensive than an assessment required merely for a short environmental report. One or more of the following elements may be included:

- Identification of surrounding sensitive receptors.
- Description of existing ambient noise environment.
- Noise survey to establish baseline levels.
- Identification of relevant assessment criteria and guidance.
- Identification of likely noise sources associated with the proposed development, and their emissions.
- Prediction of levels received at offsite receptors, using relevant standards and computation methods.
- Assessment of impact (i.e. change in level) and likely effects or significance of the change at receptors by reference to identified criteria and other relevant factors such as context.
- Identification of mitigation requirements, and their agreement with the applicant.
- Revised assessment taking mitigation into account.
- Assessment of residual, cumulative and indirect impacts.

Prior discussion between the noise assessor and the Local Authority Officer may be beneficial in some cases, or may be specifically requested by the Officer. The chief purpose of such engagement is (a) to agree the assessment methodology to be applied, and (b) to agree noise criteria against which impacts will be assessed. In most cases, the methodology and criteria to be applied will be self-evident, and prior discussion will not be strictly required.

The input of the Local Authority Officer is advisable in determining the scope and duration of a baseline noise survey (e.g. duration of survey, number and location of monitoring positions, etc.). Early consultation on these issues will allow the developer and the assessors to benefit from the Officer's local knowledge and expertise. In addition, it will allow the Local Authority's concerns and inputs to be addressed at the earliest possible juncture. Such an approach will likely be beneficial to all relevant parties and should minimise delays and/or misunderstandings and streamline the process.

In 2017, on foot of the introduction of EU Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, the EPA issued *Draft guidelines on the information to be contained in Environmental Impact Assessment Reports*. The document contains useful information on how issues such as noise and vibration are to be assessed. All noise assessment reports, whether prepared for inclusion in EIAR documents or as standalone reports, will benefit from consideration of the information included in the EPA guidance document. The document is freely available at www.epa.ie. Useful information is also provided in *Guidelines for environmental noise impact assessment* (UK Institute of Environmental Management & Assessment, 2014).

Key items to look out for in any noise impact assessment report are as follows:

- The qualifications and competence of the report author and any survey personnel and assessors should be set out.
- Any noise guidance and criteria relevant to the proposed development should be clearly identified. If guidance or criteria are not available with respect to the project, the assessor should make reference to other criteria, and justify their use.
- Surrounding noise sensitive locations should be identified.
- If a baseline noise survey is undertaken, the survey should be carried out at relevant times. For instance, night-time monitoring should be included if the proposed development will operate through the night. Weekend baseline monitoring may also be required.
- Details of the baseline survey should be included, including monitoring locations, equipment and calibration details, and weather conditions.
- All potentially significant noise sources at the proposed development site should be identified, and their expected noise output quantified by (a) reference to L_{WA} levels or $L_{Aeq\,T}$ levels (at a specified distance) provided by the manufacturer/supplier, (b) reference to typical levels such as those listed in *British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* (2014)-1:2009+A1:2014, or (c) direct measurement of the equipment onsite or at a similar facility.
- Predictive modelling, where undertaken, should be in accordance with an identified standard such as ISO 9613-2:1996, whether software based or by calculation.
- Assessment of impacts at receptors should be undertaken by reference to the identified criteria. Predicted levels may be compared to absolute limits, or to existing baseline levels, or both. The magnitude of impact may be qualified using criteria set out in a number of documents, including the EPA's 2017 EIAR guidelines document. It can be useful to show the increase (if any) in $L_{Aeq\,T}$ resulting from introduction of the proposed development.
- The requirement for mitigation should be assessed, and any identified measures should be clearly set out. Such measures should be agreed with the applicant prior to inclusion in the report. The EPA's EIAR guidelines document includes several recommendations with respect to mitigation.
- Where other noise sources of significance are located in proximity, potential cumulative impacts should also be assessed.

During the planning or permit application process, the Local Authority Officer with responsibility for noise may not be satisfied with the noise assessment, due to absence of specific details, use of inappropriate criteria, etc. The Officer may request further information from the applicant, through the Planning Department. Similarly, an Officer may request than an assessment of noise impacts be undertaken in cases where a planning or permit application has already been submitted without being accompanied by such an assessment.

At further information ('FI') stage, a Local Authority Officer should not hesitate to request any information deemed necessary to enable further consideration of the application. In many cases, a full EIAR type assessment will not be necessary, and the Officer may seek specific information relating to a particular aspect of the development or the noise environment. In all cases, the Officer is advised to refer to the key items listed above, some or all of which may be relevant. In certain cases, it may be advisable that the FI request includes a recommendation that the applicant or noise assessor contacts the Officer directly prior to compiling the requested information, in order to agree assessment criteria and/or other issues.

8. Setting limits

Most Local Authorities have tended to specify daytime and night-time limits of 55 dB and 45 dB respectively, mirroring former EPA guidance. These limits ultimately derive from World Health Organisation recommendations, as discussed in Section 6. However, the 55/45 dB limits may not be suitable for all developments, or for all noise environments. The following issues are of greatest relevance when setting limits:

Absolute, relative or hybrid

Noise limits may be divided into three types:

- **Absolute**, where noise levels are compared to absolute limits such as the 55/45 dB criteria. These are the most commonly applied limits, being relatively straightforward to assess.
- **Relative**, where noise levels are compared to limits derived from levels in the absence of the source under consideration, typically measured prior to commissioning of the source. Levels applied are usually $L_{AF90\ T}$ levels (commonly referred to as 'background' levels – see Section 2). Limits may be derived in various ways, such as by arithmetic averaging of background levels, or by using a sample noise level measured while the source is shut off, or by using a representative background level plus a specified threshold (e.g. background +5 dB). Relative limits are often applied in areas where background levels are low, and where absolute limits of say 55/45 dB would not provide the necessary degree of protection to local residents. There are three disadvantages associated with relative limits: (a) they are more complicated to assess, particularly if background levels were not recorded prior to commissioning of the source, (b) background levels can change over time, and (c) there may be some disagreement in selecting the relevant background levels to be applied when assessing compliance. There is a further issue with relative limits which relates to overall planning policy: The introduction of new noise sources to an area is likely to increase background levels over time. If each of these sources is subject to relative limits, this in effect allows background levels to gradually increase, an effect known as background noise creep. In contrast, setting of absolute limits with respect to each source will avoid such creep.
- **Hybrid** limits, incorporating both absolute and relative criteria. Some Local Authorities, for instance, specify that noise emissions from a facility should not exceed 55/45 dB limits, and in addition should not exceed background levels by more than 10 dB. Care needs to be applied in the wording of such limits. For instance, it should be clarified if background or residual levels should be assessed (see Section 2). In addition, it may be useful to consider incorporating a clause such as 'whichever is the lower' or 'whichever is the higher', as compliance with both relative and absolute criteria may not always be possible or practical.

The EPA's NG4 guidance note sets out a clear procedure whereby the selection of absolute or relative limits is determined based on background noise levels and other location-specific criteria. The selection of appropriate noise limits is entirely a matter for the Local Authority Officer.

Construction noise presents an unusual case, as emissions are temporary. In many cases, construction works will be required to install mitigation measures required to reduce operational phase emissions. Higher noise limits are typically applied to the construction phase. Construction noise is assessed more closely in Section 27.

Where applicable

Absolute, relative or hybrid noise limits may be applied at the boundary of the development, at a specified distance, or at noise sensitive locations. In the early years of noise compliance, limits were typically applied at site boundaries. Boundary limits benefit from ease of access, and avoidance of disturbance to residents. However, boundary limits have slightly fallen out of favour for several reasons, the chief reason being that it makes more sense to assess compliance directly at receptors. Furthermore, boundary positions will often fail to benefit from mitigation applied around the site, such as boundary barriers and earthen berms. Measurement of boundary levels is likely to be impractical at sites which do not benefit from onsite buffer zones (i.e. where onsite sources lie close to the boundary), and is also likely to be superfluous at sites surrounded by other industrial or commercial operators.

In recent years, application of limits to offsite noise sensitive locations has become more prevalent. In this regard, the EPA defines a noise sensitive location as:

Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires absence of noise at nuisance levels.

In order to avoid disturbance to residents, particularly where evening or night-time monitoring is required, proxy locations are often used, for instance in an adjacent field or on the road verge. Use of such positions is entirely acceptable, subject to access, particularly if the proxy location lies on the source side of the receptor such that the noise level received at the proxy location will be higher than at the receiver, thus incorporating a safety margin. The EPA's NG4 guidance note provides further advice in this regard.

Ambient v specific

Section 2 describes the difference between ambient and specific noise levels. In short, the ambient level describes the total noise level at a location, inclusive of all sources, while the specific level relates solely to the contribution from the source under consideration. The ambient level will include the specific level (if audible), in addition to any extraneous sources such as traffic, aircraft, birdsong, other commercial emissions,

etc. It is clear that the only emissions directly under the control of the site operator are the specific emissions.

A loosely worded noise limit may simply refer to noise levels e.g. 'noise levels shall not exceed 55 dB'. Such wording is open to interpretation. The wording may arguably be interpreted to mean that all emissions, including those from the operator's facility and from extraneous sources, should not exceed 55 dB. This is clearly not practical, as it implies that the operator has some degree of control over extraneous sources. At many locations, particularly near roads, ambient noise levels may already exceed 55 dB, and thus the operator will be entirely unable to meet an ambient limit of 55 dB.

This scenario may be entirely avoided by confining limits to specific levels i.e. those originating from inside the operator's boundary. This sentiment may be conveyed in a noise condition by using wording such as:

- 'Specific $L_{Aeq\,T}$ levels from the development shall not exceed…'
- 'The proposed development shall not give rise to noise levels which exceed…'
- 'The noise contribution from the development shall not exceed…'

Specific levels attributable to the source in question may be measured directly at the monitoring position, or may be determined through calculations based on measured data. In certain cases, specific levels may need to be determined through measurements made closer to the source, and then calculated out to the receiver location of interest. The EPA's NG4 guidance document provides further information here.

Periods

The NG4 document recommends the following absolute noise limits where the facility does not lie in a quiet area or area of low background noise:

- Daytime 0700-1900 h: 55 dB $L_{Ar\,T}$.
- Evening 1900-2300 h: 50 dB $L_{Ar\,T}$.
- Night-time 2300-0700 h: 45 dB $L_{Aeq\,T}$.

Two points are noteworthy here. The first is that NG4 is one of the first guidance documents to specifically recommend a separate evening limit, applicable to the period 1900-2300 h. Most documents, including the WHO documents which ultimately inform EPA criteria, continue to refer only to daytime and night-time periods. The simple division into daytime and night-time may not be suitable in all cases. For instance, a noise limit of 55 dB may be considered unduly lenient at 2200 h. Many Local Authorities have historically applied earlier night-time commencement times, such as 2000 h. However, in some cases a limit of 45 dB from 2000 h may be overly restrictive. Use of a separate evening limit of 50 dB offers a practical solution, and is likely to see more usage by Local Authorities into the future.

The second point worth noting is that NG4 applies the 55 dB daytime limit from 0700 h. In practice, most Local Authorities have been reluctant to follow suit when drafting noise limits, preferring instead to extend the night-time limit up to 0800 h. Such a

decision is a matter for the Local Authority Officer when drafting noise limits. As many facilities require commencement of operations on (or before) 0700 h, consideration should be given to permitting a daytime noise limit from 0700 h. This is particularly the case at locations exposed to high existing ambient levels from early morning, such as areas close to busy roads and to existing industry.

In the past, Local Authorities have in many cases conditioned that specified daytime noise limits apply Monday-Friday, and that limits specified with respect to night-time hours also apply to daytime hours Saturday-Sunday. This approach, and similar approaches where weekend daytime limits are lower than weekday limits, is based on historic working patterns where weekends were usually not worked. This assumption is less applicable in modern society. It is certainly no longer valid for Saturdays, and noise surveys regularly show little or no reduction in ambient or background noise levels on Saturdays. At many locations, daytime Sunday levels are also not significantly lower than weekday levels. It is therefore suggested that Local Authority Officers should not assume a default position of lower daytime limits on weekends, particularly Saturdays. Where a facility requires Saturday or Sunday opening hours, Officers should bear in mind that lower weekend limits may not be reasonable (see Section 9 below), particularly where noise data indicate that weekend ambient or background levels are not significantly lower than weekday levels.

Tones & impulses

Information provided above relates chiefly to the overall A-weighted specific noise level attributable to a facility. For instance, a specific $L_{Aeq\ 15\ min}$ level of 51 dB from a source may be compared to a daytime $L_{Aeq\ 15\ min}$ limit of 55 dB. This limit does not take the character of the noise into account.

Section 2 above discusses tones and impulses, both of which may attract a penalty. It is conventional practice to include some restriction on such features when setting limits. There are typically two approaches here.

The first approach is the place an outright ban on such features. Typical wording of such a prohibition includes ‘there shall be no clearly audible tones or impulses in facility emissions audible at offsite receptors’. The EPA’s NG4 document recommends this approach with respect to night-time emissions, hence reference to the $L_{Aeq\ T}$ criterion with respect to the period 2300-0700 h on the previous page. The $L_{Aeq\ T}$ parameter does not provide for the inclusion of a penalty for tones or impulses, and instead such features are prohibited outright during night-time hours.

Rather than prohibiting tones and impulses during the day, when residual noise levels are higher, NG4 instead recommends that such features may be tolerated, but only by adding a penalty. This is considered a reasonably practical approach, as many facilities are inherently tonal or impulsive, and to eliminate such features may be impractical. The penalty recommended in NG4 is 5 dB, and the penalised level is termed the rating level ($L_{Ar\ T}$). NG4 also refers to BS 4142:2014 which sets out a range of corrections depending on audibility and clarity of the offending features (see Table 2 in Section 6).

Intervals

When specifying a noise limit, it is insufficient to simply state that 'noise emissions from the proposed development shall not exceed a specific $L_{Aeq\ T}$ value of…' without specifying the interval T. The interval relates to the measurement time, as discussed in Section 2. Measurement intervals applied by the EPA are typically 15 minutes or 30 minutes. Quarry and construction emissions are usually assessed over intervals of one hour, as recommended in BS 5228:2009+A1:2014. Wind farm intervals are in almost all cases 10 minutes. Further guidance is set out in Part 3 of this document.

It is important to identify the distinction between measurement duration and measurement interval. The duration refers to the total time spent measuring noise levels at a particular position. In contrast, the measurement interval is the period T over which the specific $L_{Aeq\ T}$ level is averaged. Thus, for example, a measurement duration of two hours may be applied in a particular case, whereby monitoring is undertaken for a total period of two hours. Within this overall duration, one or more intervals may be assessed. If an interval of 15 minutes is applied, eight individual $L_{Aeq\ 15\ min}$ values will be logged over the two hours. Four $L_{Aeq\ 30\ min}$ values will be logged. In many cases, the duration will be the same as the interval e.g. one $L_{Aeq\ 15\ min}$ level will be logged where the measurement duration is 15 minutes.

Confusion will result where a limit refers to a monitoring period without any reference to measurement interval. As an example, a noise condition may refer to monitoring over an eight hour period without further clarification. Here, it is not clear if the $L_{Aeq\ 8\ h}$ level should be determined at the end of the 8 hour period, and this value compared to the specified limit. Alternatively, it is not clear if shorter intervals should be extracted from the data, e.g. eight individual $L_{Aeq\ 1\ h}$ values, or 16 $L_{Aeq\ 30\ min}$ values, etc., and these compared to the limit. The simplest way to avoid such ambiguity is to specify the limit parameter directly, by quantifying the interval T in the specific $L_{Aeq\ T}$ limit. The overall monitoring duration, if required to be longer than the measurement interval T, may be specified separately in the condition. Sample wording here is as follows:

'Daytime noise emissions from the facility shall not exceed 55 dB (specific $L_{Aeq\ 15\ min}$) at a receptor. Daytime monitoring shall be carried out over a total duration of 2 hours.'

It is noted that most Local Authorities do not specify the overall monitoring duration, and instead simply refer to the measurement interval T. It is worth adding here that, at a facility where several monitoring locations are specified, long durations will significantly impact on survey cost, and the survey may extend to more than one day. At most sites, one measurement interval may suffice at each noise position, if that interval coincides with a typical operations cycle. The EPA's NG4 document specifies three intervals during daytime hours, and two intervals during the night-time.

At sites where noise levels fluctuate due to variations in processes throughout the day, evening or night, consideration should be given to survey timing, with a view to ensuring that noise measurements represent the typical noise cycle.

Consistency

As a facility develops and expands over time, it is inevitable that the site will be subject to multiple planning permissions. Some of these permissions may relate to extensive onsite developments, such as a new manufacturing building or a large extension, while others may relate to ancillary infrastructure such as a canteen, an emissions stack, a carpark, etc. Each planning permission may include a noise condition.

Complications may arise where the noise conditions are not consistent. For example, a facility may be subject to the standard 55/45 dB limits through one permission, and may be subject to a relative limit (e.g. background +5 dB) through another permission. An earlier permission may apply noise limits at the site boundary, while a later permission may apply limits at offsite receptors. Limit times may vary e.g. a daytime limit to 2200 h through one permission, and to 2000 h through another. Some conditions may be worded so that limits apply to the entire site, while others may refer to emissions from the proposed development. In the latter case, limits may apply solely to the development for which permission has been granted, rather than to the overall facility.

Consistency of limits is important to minimise complications in undertaking surveys, calculating levels specific to onsite sources, and assessing compliance. It is also important to bear in mind that application of strict or unsuitable limits through a new permission may be unfair or impractical where a facility has incorporated mitigation and control measures to achieve compliance with earlier limits. As an example, a facility which has been required to meet a night-time limit of 45 dB through one or more permissions, and which has designed, purchased, installed and improved onsite sources to meet this limit, may struggle to meet a relative limit (e.g. background +5 dB) specified in a new condition, particularly if that condition is worded so as to apply to the site in its entirety. While the Local Authority may deem that the new condition is required to protect new receptors in the vicinity of the facility, it should not be forgotten that this situation has been created as a result of the Authority's decision to grant permission for those new receptors.

In specifying noise limits to be included in any new permission, it is advisable that the Local Authority Officer considers any existing noise conditions applicable to the facility. The Officer should also have regard to the six tests described in Section 9, bearing in mind that application of new stricter limits may not meet all tests.

The Officer should additionally pay heed to any criteria set out in the Authority's development plan or noise action plan. AACI members have reported several cases where noise limits attached to planning permissions are entirely inconsistent with criteria set out in the Local Authority Development Plan in force at the time permission was granted.

9. Drafting conditions

Noise conditions require careful wording to eliminate any ambiguity. Noise conditions attached to a planning permission or waste permit (or potentially an air emissions licence) are likely to represent the chief method of noise control at that facility for many years. While permits and licences are typically reviewed at intervals, a planning permission may be in effect for several decades. Potential future complications may be eliminated by consideration of condition wording at the outset. In this regard, it is noted that a tendency in recent years to 'copy and paste' conditions from permission to permission has often resulted in impractical conditions, or conditions which are more or less unenforceable.

When drafting a noise condition, six tests may be applied by the Local Authority Officer to assess the suitability of a condition:

- Is the condition necessary? Not all developments may require a noise condition. The argument that inclusion of a noise condition 'will do no harm' is not a justification for its imposition. In general, a condition should not be imposed unless there is a definite need for same. A simple test here is to ask if planning permission would have to be refused if the noise condition were not imposed.
- Is the condition reasonable? A noise condition may be considered reasonable only if the applicant can reasonably be expected to comply with it. For instance, installation of a large noise barrier may require a separate application for planning permission, which may be refused, or access to land outside the control of the applicant. A condition deemed unduly restrictive may also be considered unreasonable, particularly if its imposition will result in severe financial implications or closure of the facility. Subsequent enforcement action is likely to fail if it can be shown that the noise condition cannot reasonably be complied with.
- Is the condition enforceable? A noise condition should be enforceable in order to be effective. An example here is an inability to assess compliance with a condition, due to its wording or due to a technical issue. Another issue which appears regularly is difficulty assessing compliance with background noise levels if such levels have never been measured and stored prior to introduction of the source, and where such levels may not be readily measured now. The Local Authority Officer should consider how easy it would be to assess compliance with the condition.
- Is the condition precise? This is of particular relevance to noise, where a condition may be interpreted in a number of ways, through reference to vague parameters (as an example, see 'ambient v specific' in Section 8). Ambiguity should be avoided by clearly setting out limits, parameters and intervals as discussed in Section 8. Vague and imprecise conditions cannot be enforced. For instance, the clause 'noise emissions shall not give rise to nuisance' is not precise, as nuisance is a subjective issue.
- Is the condition relevant to planning? A noise condition should only be imposed by the Local Authority for planning reasons, acting as a planning authority. A noise condition imposed on, say, a proposed nightclub in order to reduce

internal music noise levels to avoid damaging hearing of patrons may be considered not relevant to planning.

- Is the condition relevant to the development? The noise condition should be justified by the nature of the proposed development i.e. the condition should be included where a potential noise impact may arise as a result of the proposed development. It is inappropriate to include a noise condition to regulate a noise issue unrelated to the proposed development. The key test here is as follows: Is the need for the noise condition justified by the proposed development itself, or is the need for the condition a result of an issue which is unrelated to the proposed development? If the latter situation applies, then the noise condition is not directly relevant to the proposed development.

With respect to noise limits included in noise conditions, the reader is directed to Section 8. Additional sector-specific guidance is presented in Part 3. Any limits should be clear and unambiguous.

Noise conditions may extend merely beyond specifying limits to which the applicant should adhere. Conditions may also be included in relation to monitoring requirements and reporting. With respect to these, the following should be borne in mind:

- Routine noise monitoring may be an expensive imposition on an operator. Specifying repeated or continuous monitoring may be excessive and superfluous in many cases. Provision may be made for 'front loading' the monitoring i.e. several surveys may be useful during the months or initial years following commissioning of the development. Thereafter, surveys may be relaxed if continued compliance is indicated.
- It may be useful to allow some flexibility in the monitoring programme, to provide for changes in site operations, the local noise environment, the addition of new receptors, changes in monitoring techniques and equipment, etc. Such flexibility may allow a decrease in the level of monitoring, where compliance is repeatedly demonstrated, or an increase in monitoring where issues such as complaints arise.
- Conditions relating to monitoring often include a requirement to submit noise reports to the Local Authority within a specified period. It should be noted that data analysis and report preparation may take several weeks, depending on the project. It is therefore recommended that a submission period of one month be provided for any such condition.

It is important to bear in mind that a noise condition attached to a permission of planning is likely to be the only noise restriction pertaining to that site, if the operation is not subject to EPA licensing or a Local Authority waste permit. The only enforceable noise control, without resorting to a S.107 notice (see Section 5 above), will be the planning permission and its conditioned noise limits. These limits may remain relevant for several decades. It follows that when drafting a noise condition, the Local Authority Officer should be cognisant of the present situation, but should also consider potential changes which may arise in the future.

As an example, a noise condition attached to a planning permission may specify that noise emissions from the site in question should not give rise to noise levels above a certain limit at a particular receptor. The receptor may be identified as 'the nearest

house to the north', or as 'H1', etc. The identified receptor may indeed be the most vulnerable receptor at the time of grant. However, the receptor may subsequently become unoccupied, or may be purchased by the applicant. Closer receptors may subsequently be built. Thus the noise condition should be worded so as to minimise the possibility for it to become obsolete and/or impractical to enforce.

A similar issue here is the widespread inclusion of the term 'the nearest dwelling' when specifying where limits apply. In its strictest sense, the interpretation of such phrasing is that the specified limits apply only at the nearest dwelling, and that limits are not relevant to any other receptor. This situation is obviously not ideal. Numerous factors, such as the characteristics of the noise, topographical features, differing background conditions, and local attitudes to the source, may result in greater impacts at more distant receptors. The nearest dwelling may not be the most vulnerable or exposed.

10. Integrating planning & noise management

Local Authorities are empowered to impose consent conditions regarding noise as part of permissions issued under Planning and Development legislation. However, there is currently no national policy or guidance which addresses the issue of environmental noise in the context of Planning and Development. This can lead to omissions and inconsistencies in the assessment and conditioning of planning applications.

The EPA document *Guidance note for noise action planning* (2009) states:

If the overall aims of noise action plans are to be realised, it is important that the planning of new residential properties, or other noise sensitive buildings, is carefully considered and suitable conditions applied to ensure that they do not just produce an increase in the population exposed to high levels of environmental noise. Aspects such as façade orientation, room usage, façade construction, window construction, use of passive or active air vents, site boundary noise mitigation, creation of quiet gardens or courtyards, could all be imposed as conditions during planning to help reduce the exposure of the population.

The document adds that the framework of the Environmental Noise Regulations (S.I No. 140 of 2006) and the action plans:

…creates an opportunity to set out design targets and guidance at national or local level in order to help ensure that future developments include provisions to protect the population from the effects of environmental noise. Planning guidance relating to noise would help to support the aims of the Environmental Noise Regulations and Noise Action Plans by providing tools for the planners to use when assessing and granting new developments.

Unfortunately, however, national planning guidance relating to noise has not emerged to date. In 2018, the EPA issued an updated draft *Guidance note for noise action planning* (2018, draft). The document states:

The EPA view is that there is still a need for planning guidance which could outline some of the main noise elements that would need to be considered by planners, such as:

- demonstrating a good acoustic design process;

- observing internal noise level guidelines;

- undertaking an external amenity area noise assessment.

It is clear that the Planning and Development system has the potential to provide an anticipatory and proactive means by which exposure to environmental noise can be controlled and/or minimised, although no guidance has been issued. In the absence of national guidance, Planning Authorities are encouraged to reference UK guidance such as *ProPG Planning & noise: Professional practice guidance on planning & noise – New residential development* (May 2017).

In the meantime, this AACI guidance document sets out to address the shortfall in national guidance and to provide practical and user-friendly assistance.

It is noteworthy that environmental noise impact should not be assessed in isolation during Planning and Development. Moreover, it should be systematically considered and assessed in a balanced and integrated manner with other pertinent issues such as national, regional and local policy, land use zoning, sustainability, population trends, need for the development, economic and social benefits, etc.

It is worth adding here that most noise complaints investigated by AACI members are a direct result of poor planning, whereby noise sources are placed too close to receptors, or new receptors are permitted in proximity to existing noise sources. This is particularly evident in rural areas, where the development of quarries, wind farms and other facilities is hindered due to one-off dwellings. Another example commonly encountered is the construction of residential developments close to commercial/industrial zones. In many cases, existing commercial/industrial areas cannot be expanded due to recent construction of residential developments in the local area.

Facilities such as wind farms, quarries, shipping ports, etc. are resource-dependent, and may only be sited in specific areas. Other facilities require resources such as large land banks, access to the national road network, water supply, three phase electricity, rail connection, proximity to certain other facilities, etc. Such areas should ideally be protected by enforced zoning. The absence of an appropriately enforced land zoning system which provides adequate buffer zones between receptors and inherently noisy developments is the root cause of most environmental noise issues. This is linked to the failure to anticipate and access incompatible developments. The ideal planning system would set out clear zoning policies a decade or more in advance, and would prohibit residential developments and one-off houses in identified zones.

PART 3:

SECTOR SPECIFIC GUIDANCE

11. Industrial installations (outside of those regulated by EPA)

Standards & guidance

Industrial installations regulated by the EPA are typically subject to noise limits drawn from EPA document *NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities* (2016). On this basis, NG4 is also arguably the most relevant guidance document with respect to industrial facilities regulated by Local Authorities.

Useful guidance is additionally presented in *British Standard BS 4142:2014 Methods for rating and assessing industrial and commercial sound* (2014), which provides an assessment methodology based on existing background levels.

Typical issues

- Many industrial facilities operate extended hours or 24/7. Background noise surveys should include daytime, evening, night-time and weekend periods as appropriate.
- Industrial facilities often include a number of noise sources scattered around the site. All such sources should be identified and assessed in the noise assessment report.
- Some industrial noise sources such as fans and condensers may give rise to tonal noise emissions. Consideration of such emissions should be included in the assessment.
- Industrial facilities may be concentrated in industrial zones. Potential cumulative impacts may arise at nearby receptors, and such impacts should be included in the assessment.
- The Local Authority Officer should be satisfied that any noise assessors involved in compliance work or impact assessment demonstrate the required level of competence.

Setting limits

NG4 sets out a clear process for the assignment of noise limits. While most Local Authorities typically assign only daytime and night-time limits, inclusion of separate evening limits, in accordance with NG4, may be warranted. In addition, the setting of the daytime noise limit from 0700 h, as recommended by NG4, may be appropriate in certain cases, rather than the 0800 h start typically preferred by Local Authorities.

NG4 notes that noise limits are typically set at facility boundaries in industrial estates, and are set at offsite noise sensitive locations for facilities outside such zones. However, most licences currently issued by the EPA specify limits at offsite receptors rather than at boundaries. Bearing this in mind, it is considered that receptor limits are more relevant than boundary limits.

It is important to note that NG4 allows for the setting of higher limits at boundaries, as onsite noise sources may be located nearby. If boundary limits are required, such higher limits may be relevant. It is reiterated here, however, that application of noise limits to offsite receptors is generally preferable, particularly as many facilities have little or no onsite buffer space between noise sources and the perimeter.

12. Waste facilities (outside of those regulated by EPA)

Standards & guidance

Like industrial installations, waste facilities regulated by the EPA are typically subject to noise limits drawn from their NG4 document. NG4 is therefore considered to be the most relevant guidance document with respect to waste facilities regulated by Local Authorities, both through planning permission and waste facility permits. Such facilities include civic amenity sites and waste transfer stations. Scrap metal facilities are assessed separately in Section 13. Land reclamation sites are more appropriately assessed using guidance given in Section 16.

Useful guidance is additionally presented in BS 4142:2014, which provides an assessment methodology based on existing background levels.

Typical issues

- Many waste facilities operate extended hours or 24/7. Background noise surveys should include daytime, evening, night-time and weekend periods as appropriate.
- Waste transfer stations may be associated with a large number of compactor truck movements during early morning hours, with potential impacts at nearby receptors.
- Wood shredding plant used at some waste management facilities may generate particularly loud emissions over sustained periods. Such emissions may require mitigation, including erection of a building or noise barrier.
- Metal clanging due to movement and manipulation of skips may generate impulsive emissions. These will require consideration.
- Given the large number of employees and contractors who may access the commissioned facility, consideration should be given to preparation of a noise management plan and appropriate training.
- Waste transfer stations may be concentrated in industrial zones. Potential cumulative impacts may arise at nearby receptors, and such impacts should be included in the assessment.
- Local Authority Officers should satisfy themselves that any noise assessors involved in compliance work or impact assessment demonstrate the required level of competence.

Setting limits

NG4 sets out a clear process for the assignment of noise limits. As with industrial sectors, assignment of limits to offsite receptors is considered more relevant than boundary limits. Given that most waste management facilities are likely to commence daily operations relatively early, the setting of the daytime noise limit from 0700 h, as

recommended by NG4, may be appropriate in certain cases, rather than the 0800 h start typically preferred by Local Authorities.

13. Scrap metal facilities (outside of those regulated by EPA)

Standards & guidance

Larger scrap metal facilities are regulated by the EPA, with noise limits informed by their NG4 document. NG4 is therefore arguably the most appropriate guidance document with respect to scrap metal facilities regulated by Local Authorities, both through planning permission and waste facility permits. Guidance here is also relevant to dock sites where scrap metal is loaded onto vessels for export.

BS 4142:2014, which provides an assessment methodology based on existing background levels, may also be appropriate.

Typical issues

- Manipulation of metal by mobile grabs, and tipping of metal, may generate significantly impulsive emissions. These may be minimised through effective management.
- Some scrap metal facilities shred metal using fragmentation plants. Noise emissions from such plants may be particularly high, requiring large separation distances to receptors, or erection of barriers.
- Local Authority Officers should confirm that any noise assessors involved in compliance work or impact assessment provide competency details.

Setting limits

NG4 sets out a clear process for the assignment of noise limits. As with industrial sectors, assignment of limits to offsite receptors is considered more relevant than boundary limits.

Noise emissions from scrap metal facilities are inherently impulsive, and it is difficult to eliminate such emissions. A blanket ban on impulsive emissions may be impractical when drafting noise conditions for such facilities, and may not be reasonable (see Section 9). It may be more appropriate to include a condition that specific $L_{Aeq\ T}$ emissions from the facility be rated (i.e. penalised) to take impulsive features into account. Rating corrections are recommended in both NG4 and BS 4142:2014.

14. Commercial facilities

Standards & guidance

Commercial facilities include a broad range of premises such as business parks, warehouse units, retail premises, service stations, distribution depots, production units, grain drying facilities, hotels, service centres, and so on. They also include smaller facilities such as fast food restaurants, laundrettes, etc. None of these benefits from any sector specific guidance.

The EPA's NG4 document, and BS 4142:2014, are again considered to be the most suitable guidance documents.

Typical issues

- Consideration should be given to the typical issues identified in Section 11 with respect to industrial installations.
- Unlike industrial installations, smaller commercial facilities are more likely to be found close to receptors, particularly in urban areas. Noise impact assessments should take all surrounding receptors into account.
- Sources typically found at commercial facilities include air management systems, fans, vents, air conditioning cassettes, refrigeration units and compressors. Emissions from such sources may be tonal or near-tonal. Many such units are located on roofs or high up on facades, resulting in less screening.
- At service stations, elevated emissions will arise from drive-through and manual carwashes if present. Washing stations are usually located at the side or rear boundary of the site, and thus in proximity to receptors outside the boundary.
- Any facility where metal is manipulated (e.g. fabrication facilities and steel merchants) will inevitably generate impulsive emissions due to clanging metal.
- Most commercial facilities involve some degree of loading or unloading. The reader is referred to Section 15.
- Intelligent facility layout is a key mitigation feature at commercial facilities. Offsite noise issues will be minimised by siting onsite noise sources away from receptors, and by using the building itself to screen emissions.
- Local Authority Officers should satisfy themselves that any noise assessors involved in compliance work or impact assessment demonstrate the required level of competence.

Setting limits

As the process of devising noise limits for commercial facilities is likely to be similar to that for larger scale facilities, the reader is referred to Section 11. The same considerations generally apply.

Unlike larger industrial facilities, most commercial premises do not benefit from buffer space between onsite noise sources and the site boundary. In many cases, onsite sources and offsite receptors may lie in close proximity on either site of a shared boundary wall. Application of noise limits to the site boundary may not always be practical, for several reasons:

- In certain cases, setting noise limits at the boundary may be restrictive, particularly if there are onsite noise sources close to the boundary. Boundary limits will be particularly irrelevant if there are no receptors outside that boundary, and if siting noise sources at this position represents the optimum acoustic design.
- Noise levels measured at the boundary may not accurately represent emissions propagated offsite towards receptors. For instance, a boundary noise measurement position set at the typical measurement height of 1.2-1.5 m above ground level may be screened from an onsite noise source directly overhead on the façade or on the roof. In such a scenario, the boundary position will be entirely unrepresentative of emissions propagated over the boundary to nearby receptors.
- At many facilities, particularly those in urban areas, access to the boundary is not possible. Even where access is possible, space may be limited. A narrow walkway between the rear façade of a commercial building and a high boundary wall is not suitable for noise measurement, as free-field conditions will not be attainable. Measurements made close to walls may require façade corrections. Details of any such corrections, including their calculation, pertinent details and references, should be included in the report.

In order to eliminate the above complications, the application of limits to offsite receptors may be more practical. However, in some cases access to offsite receptor positions may not be available or granted (particularly in acrimonious cases), and alternative positions will need to be selected. Where such alternative positions are used, measured data can be used to calculate the specific noise level at the receptor(s).

15. Deliveries

Standards & guidance

Most facilities will require deliveries, whether inward, outward, or both. Such activities are rarely subject to separate limits, and in almost all cases, delivery emissions are subject to noise limits and standards applicable to the overall site.

A number of UK authorities, including the Department for Transport, and Transport for London, have issued guidance documents and codes of practice with respect to quiet delivery methods.

Typical issues

- Delivery activities may give rise to impulsive emissions such as tailgate banging. Other distinctive emissions include forklift truck and pallet truck noise on truck beds, and trolley movements. A common issue is fork rattle as a forklift truck traverses bumps, lips and defects on yard surfaces.
- As trucks manoeuvre into position, emissions may arise from engine noise, brake release and reversing alarms. These sources may give rise to a combination of tonal and impulsive emissions.
- Emissions from refrigerated truck engines are usually audibly tonal around 50-100 Hz.
- Deliveries at many facilities occur during night-time or early morning hours.
- One of the most effective methods to reduce delivery noise impacts is to locate delivery zones as far as possible from offsite receptors, for instance at the far side of a building. Potential for delivery noise intrusion should be factored into layout design from the outset of a project. At several recently constructed premises, AACI-registered noise assessors have traced ongoing noise issues to poor siting of loading bays. At these sites, it is evident that potential noise impacts were not assessed by the project team at design stage, or by the Local Authority at planning stage.
- At smaller facilities including retail premises, deliveries will often occur on the street outside the premises. This may give rise to nuisance at surrounding receptors, even though such activities may arise outside the site boundary. Little or no guidance is available here. It is worth remembering that BS 4142:2014 refers to local context when assessing impacts. At urban locations, it is arguable that delivery noise forms part of the normal urban soundscape.

Setting limits

Noise limits specific to delivery operations are rarely specified, and delivery emissions are usually subject to limits which the Local Authority Officer deems appropriate to the overall facility. Consideration should be given to delivery times and noise limits, bearing in mind that restricting deliveries to certain periods may not be practical for the operator.

16. Quarries

Standards & guidance

In 2004, the Department of the Environment, Heritage & Local Government (DOEHLG) issued *Quarries & ancillary activities: Guidelines for planning authorities*. Although initially issued to provide guidance with respect to the 2005-2007 quarry registration process as set out in Section 261 of the Planning & Development Act 2000, the DoEHLG document remains valid and in force. The document draws on guidance presented in EPA report MS-2000-M1, subsequently published in 2006 and titled *Environmental management guidelines: Environmental management in the extractive industry (non-scheduled minerals)*. These documents are the most relevant Irish guidance documents available.

British Standard BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise (2009) is often used in the assessment of quarry noise emissions.

Typical issues

- At hard rock quarries, drill rigs constitute a potentially significant source, as they typically operate on higher ground, and thus may not benefit from screening by perimeter berms.
- Rock breaking, if required, generates impulsive emissions, and is often the source of greatest potential annoyance.
- Hard rock quarries are usually worked out by blasting which may give rise to ground borne vibration and air overpressure emissions (see Sections 28 & 29). From an acoustic point of view, blasting is likely to be less intrusive than other extraction methods such as rock breaking and ripping.
- Sand and gravel pits are in most cases significantly quieter than hard rock quarries, due to the relative ease of extraction and the reduced requirement for crushing, if any.
- Truck movements on haul roads, access roads and offsite haulage routes may be significant, and may require assessment. However, it should be noted that noise limits will apply only to operations within the site boundary. It is also arguable that offsite truck noise is beyond the control of the quarry operator, and thus beyond the remit of the assessment.
- Quarry sites can be large, with extraction being undertaken over several benches across a number of phases. Predictive modelling should reflect same, and thus each phase should be modelled separately.
- Local Authority Officers should be satisfied that noise assessors involved in compliance work or impact assessment are suitably competent.

Setting limits

The DOEHLG guidance and the related EPA document recommend a daytime noise limit of 55 dB, measured using the $L_{Aeq\ 1\ h}$ parameter, applicable at offsite receptors. More relaxed noise limits may be warranted for initial construction works such as perimeter berm erection (and overburden stripping required to provide berm soil), as these will mitigate later operational emissions. A temporary construction phase $L_{Aeq\ 1\ h}$ limit of 65 dB is often applied.

Concrete and asphalt batching plants may require early starts in order to facilitate customer projects. Consideration may be given to suitable noise limits for early starts. Certain projects may require occasional night-time operation of such plants.

17. Wind farms

Standards & guidance

The most authoritative noise guidance document available with respect to wind farms is *The assessment and rating of noise from wind farms* (report ETSU-R-97 prepared by ETSU for the UK Department of Trade and Industry, 1996). Due to repeated inconsistencies in its interpretation, the UK Institute of Acoustics was commissioned to produce updated guidance in how ETSU-R-97 should be applied. The IOA document *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (2013), and the original ETSU document, represent current best practice.

In 2006, the Department of the Environment, Heritage and Local Government (DOEHLG) issued *Planning guidelines on wind energy development*. The document includes daytime and night-time noise criteria. As criteria included in the document are evidently derived from ETSU-R-97, it is considered more robust to base noise assessments on the ETSU and IOA documents, particularly as the DOEHLG document is somewhat vague. The document has been undergoing a protracted review process for several years.

All documents mentioned above recommend use of the $L_{AF90\ 10\ min}$ parameter to describe turbine noise levels. $L_{AF90\ 10\ min}$ levels are correlated with wind speed at turbine hub height. However, conventional practice is to report data with respect to a height of 10 m, using a standardised formula to correct from hub height to 10 m height. This is termed a 'standardised' height of 10 m.

Typical issues

- Noise limits in ETSU-R-97 and DOEHLG guidance are based on background noise levels, measured prior to turbine commissioning, or while turbines are shut down. In practice, wind farm operators are unwilling to shut down turbines, due to the significant cost implications. Thus background noise data should be sought prior to turbine commissioning.
- During a noise survey, it may not be possible to obtain corresponding wind speed data at turbine hub height. Wind speed measured at a lower height(s) may be used to calculate hub height wind speed, using a correction for wind shear (shear describes the increase in wind speed with increasing height). Wind shear is site specific, and is typically determined through long term wind measurement. Where wind speed data are corrected for height using wind shear factors, such factors should be included in the report.
- Following commissioning of a wind farm, subsequent compliance testing requires reference to background noise data and wind shear data. Without this information, assessment of compliance will be difficult, if not impossible. Unless the information is stored with the planning file, and made available on request, it will be almost impossible for any noise assessor, other than those directly

retained by the wind farm operator, to undertake an assessment of compliance. Therefore, it is highly recommended that the Local Authority requests this information during the planning process, and that the information is stored in the planning file for later retrieval as required. It is important to note that such information is rarely included in EIS/EIAR documents due to dataset size.

- Noise modelling should be undertaken in accordance with the above IOA guidelines. All factors should be clearly set out, including wind shear corrections.
- Modelling is unable to predict the likelihood of tones or amplitude modulation. The preferred approach here is that the noise condition be worded to address the presence of such features if they arise following commissioning.
- Wind farm noise impact assessments and compliance surveys should only be undertaken by suitably qualified personnel with experience in this area. Details of competence should be provided in all reports.

Setting limits

At the outset, it is important to note that turbine noise limits should refer to the $L_{AF90\ 10\ min}$ parameter, as recommended in the various guidance documents. No reference should be made to $L_{Aeq\ T}$ levels, or to ambient noise levels.

At present, $L_{AF90\ 10\ min}$ limits recommended by the DOEHLG document are considered the most relevant, given their government approval. The limits may be interpreted as follows:

- Daytime limit of 5 dB above background, subject to a lower fixed limit of 45 dB.
- Night-time limit of 5 dB above background, subject to a lower fixed limit of 43 dB (although the DOEHLG wording is particularly vague here).
- Where background noise levels are less than 30 dB, a daytime absolute limit set between 35 and 40 dB. No information is provided here with respect to a corresponding night-time limit. In addition, it is not stated if an increase of 5 dB over background is applicable with rising wind speed. This represents an example of the ambiguity of the document.

In the absence of any clarification in the DOEHLG document, daytime and night-time hours may be assumed to be 0700-2300 h and 2300-0700 h respectively.

These limits are applicable to external positions at receptors, and not to the wind farm boundary. In certain situations, emissions from turbines may be tonal, or may result in amplitude modulation. Both features may give rise to annoyance. When drafting noise conditions, it is prudent to include a requirement that such features be investigated where alleged to arise.

It is recommended that a noise survey is undertaken at the nearest receptors within six months of commissioning of a wind farm.

18. Single wind turbines

Standards & guidance

Although the assessment of a single turbine should be simpler than a multi-turbine wind farm, the available noise guidance is more variable. The ETSU-R-97 document referenced in Section 17 recommends a simplified assessment method for single turbines, stating that a $L_{AF90\ 10\ min}$ limit of 35 dB up to wind speeds of 10 m/s (at 10 m height) should offer sufficient protection at receptors, and that background surveys to derive relative limits should be unnecessary. The DOEHLG document *Planning guidelines on wind energy development* (2006) does not make any reference to single turbine developments.

In 2011, the EPA issued *Guidance note on noise assessment of wind turbine operations at EPA licensed sites*. The document recommends setting limits with respect to cumulative emissions from both turbines (whether one or more turbines) and other site sources. These limits are 55 dB $L_{Ar\ T}$ during the daytime and 45 dB $L_{Aeq\ T}$ at night. In addition, the turbine noise emissions alone are not to exceed 45 dB $L_{Aeq\ T}$ at any time. Although this guidance applies only to EPA regulated sites, Local Authorities may wish to consider using the guidance when assessing planning applications for industrial or commercial facilities proposing to install a single turbine.

The Planning and Development Regulations 2008 (S.I. No. 235/2008) provide a planning exemption for certain renewable energy sources, including single wind turbines, at industrial, commercial, agricultural or public sites. The exempted development is required to comply with a number of criteria, including a requirement that noise levels shall not exceed 43 dB at the nearest party boundary. No further clarification of this limit is given, and thus it is not clear what measurement parameter applies.

Typical issues

- A review of the guidance identified above suggests that background noise surveys are not required for single turbine developments. As the various limits identified are absolute rather than relative, knowledge of background noise levels is not strictly necessary. However, the Local Authority may wish to consider background noise levels in order to assess impacts.
- If the Local Authority chooses to apply a relative limit rather than one of the absolute limits identified above, it will be necessary to correlate background noise levels with wind speed. It will additionally be necessary to request that applicant to make all data available for storage with the planning file, to allow subsequent assessment post-commissioning.
- Noise modelling should be undertaken in accordance with the Institute of Acoustics wind farm guidelines identified in Section 17. All factors should be clearly set out, including wind shear corrections.

- Modelling is unable to predict the likelihood of tones or amplitude modulation. The preferred approach here is that the noise condition be worded to address the presence of such features.
- Local Authority Officers should be satisfied that noise assessors involved in compliance work or impact assessment are be suitably competent.

Setting limits

It is arguable that extensive background surveys and wind speed measurement are excessive for a small-scale single turbine developments. It is therefore suggested that an absolute limit be applied, taken from one of the guidance documents discussed above, rather than a relative limit.

If a decision is taken to apply the 43 dB limit referenced in S.I. No. 235/2008, it is suggested that use of the $L_{AF90\ 10\ min}$ parameter may be most appropriate. It is also suggested that this limit should refer to the specific turbine level, and thus it may be necessary to subtract the background $L_{AF90\ 10\ min}$ value.

It may be prudent to include a requirement that the turbine does not give rise to tones or amplitude modulation noise. It is recommended that a compliance noise survey is undertaken within six months of commissioning.

19. Solar farms

Standards & guidance

Given that the installation of solar farms in Ireland is a relatively new development, it is not surprising that little or no noise guidance exists. While several UK authorities such as Cornwall Council have issued guidance documents, these make little or no reference to noise. Cornwall Council's 2016 guidance document merely recommends that onsite noise sources be located as far as possible from receptors, and/or enclosed.

The Planning and Development Regulations 2008 (S.I. No. 235/2008), which provide a planning exemption for certain small scale renewable energy sources including solar panels, specify that noise levels shall not exceed 43 dB at the nearest party boundary. The measurement parameter is not defined.

Typical issues

- One of the main reasons for the paucity of noise guidance with respect to solar farms is that such developments are not recognised as major noise sources. There is no history of noise issues, unlike, for example, wind farms.
- Solar farms are usually constructed in rural areas where background noise levels are lower. Background levels may be particularly low in areas removed from road traffic noise, and 'quiet area' criteria as described in the EPA's NG4 document may apply.
- Construction works may be extensive, occurring over a large area and over an extended period. Any noise assessment should include an assessment of construction noise impacts.
- The chief noise sources at a commissioned solar farm are inverters, typically located in several cabins around the site. These emit continuously throughout the day, from sunrise. In addition, there are likely to be one or more transformers, located in cabins or a substation. Any assessment should take emissions from these into account. Good design will locate such sources as far from receptors as possible.
- As inverter and transformer emissions will commence from daybreak, any background noise survey should include the early morning period, bearing in mind that such data may be significantly affected by the dawn chorus.
- While reference to potential wind channelling noise (aeolian tones) between solar panels has been made in objections to several early solar farm applications, there is no evidence to suggest that such emissions actually occur, and none have been reported in Ireland or the UK.
- Local Authority Officers should be satisfied that noise assessors involved in compliance work or impact assessment are suitably competent.

Setting limits

In the absence of any specific guidance, the Local Authority Officer may choose to apply EPA NG4 limits, taking into account NG4 criteria with respect to ‘quiet areas’ and ‘areas of low background noise’.

20. Pubs & clubs

Standards & guidance

Noise emissions from pubs and clubs may arise from a variety of associated sources, including mechanical services equipment, deliveries and waste disposal, and noise from patrons. However, breakout music noise is the source that gives rise to the majority of complaints within the sector.

There is no formalised, universally applied method for assessing music noise from pubs and clubs. In Ireland and the UK, reference is usually made to the *Good practice guide on the control of noise from pubs and clubs* (Institute of Acoustics (IOA), 2003), and *Effective management of noise from licensed premises* (British Beer and Pub Association, 2003). These give straightforward, practical guidance on how to reduce noise emissions from venues and minimise the adverse impact on the local community.

When noise management policies have been exhausted, it may be necessary to use acoustic rating criteria to determine the extent of the problem. Objective methods used in the UK and Europe usually take the form of an absolute test, where noise thresholds are specified, or a relative test, where noise from the venue is assessed against pre-existing background levels. The former might, for example, be used to specify noise limits where it is not possible to measure the background level for comparative purposes, whereas the relative method is often applied to assess the potential impact of existing entertainment venues on proposed new developments, or to set levels for existing premises.

The IOA is expected to issue their document *Good practice guide for the assessment and control of noise from places of entertainment* shortly. The aim is for the draft good practice guide (GPG) to be used as a framework to establish noise level requirements appropriate to the degree of risk of a noise problem. For example, under the GPG, a rural pub that has music entertainment once a month ending before midnight would not be treated as stringently as a nightclub in a densely populated urban area that operates every night until early morning hours. There are a range of factors to consider, and the GPG risk assessment will assess these factors to rate a premises as low, medium or high risk. Depending the risk rating, appropriate sound level based control thresholds can be derived from a range of metrics and values suggested in the GPG which can inform relevant control measures if required. As with all IOA guidance, the forthcoming GPG is likely to be widely applied in Ireland.

Typical issues

- The allowable music noise level over the period of measurement at 1 metre from a receptor's facade will often be quantified in terms of the $L_{Aeq\ T}$. The limitations of this descriptor when it comes to assessing music noise should be borne in mind, however, as research has shown that A-weighted dB values are a poor indicator of annoyance in situations where there is a strong bass

element. When it comes to setting limits, therefore, it is recommended that an additional low frequency assessment is carried out.

- The prominence of low frequency components can be ascertained by comparing levels in one-third octave bands below 160 Hz against the background levels at these frequencies in the absence of music. Bearing in mind that non-continuous noise can be perceived as less acceptable than steady noise, further analysis based on the $L_{AF10\ T}$ versus $L_{AF90\ T}$ percentile parameters at low frequencies may reveal that the music features a prominent bass beat. In general, exceedances of around 5 dB at a dwelling's facade may indicate that it is audible inside and may be unacceptable to the resident.
- Alternatively, in situations where low frequency background levels are not available for comparison, it may be useful to refer to the absolute limits given in the German Standard DIN 45680, which, while not specifically intended for entertainment noise, have been shown to be a good predictor of annoyance due to low frequency music noise. The forthcoming IOA GPG may offer further advice here.
- Whenever complex percentile levels and spectrum analysis is required, or where the venue and receptor are attached or share adjoining structures, it may be appropriate to employ a suitably qualified acoustic assessor.
- Noise assessors involved in pub/club impact assessment or compliance surveys should be suitably competent.

Setting limits

The 2003 IOA document referenced above does not specifically recommend noise limits, as the working group responsible for the document was unable to come to a consensus. Limits have been suggested in a working draft annex subsequently issued by the IOA working group (see References). The forthcoming IOA GPG may offer further advice.

It has become widely accepted that the ultimate noise control objective should be to ensure that the music is at such a level that it is acceptable to a resident of a nearby noise sensitive property. The stringency of the limit imposed will depend on the frequency of events and the venue's hours of operation, but this will often mean that the music should be virtually inaudible inside the dwelling, even with the windows slightly open.

It may be appropriate to specify separate limits for other non-music sources at the facility, such as air extraction systems. Section 14 may be referred to here.

21. Concerts & festivals

Standards & guidance

The UK Noise Council document *Code of practice on environmental noise control at concerts* (1995) is widely used in setting environmental noise guidelines for large music events. The document recommends music noise level (MNL) limits at nearby noise sensitive premises for concerts taking place in a range of venues and locations.

Typical issues

- Audience satisfaction at large music events depends on average A-weighted sound levels at the mixing position (normally situated towards the back of the audience area) being in the region of 90-95 dB, with levels at many concerts, particularly during headline performances, exceeding 100 dB. Sound propagation testing undertaken at concert planning stage may reveal that in order to stay below the threshold at a noise sensitive location, levels within the venue may need to be under 90 dB, and hence issues may arise regarding the viability of the event.
- Local noise sources in the vicinity of a receptor, from traffic or commercial facilities for example, may contaminate sound level readings. In order to account for this, a series of short term $L_{Aeq\ T}$ measurements recorded while the music is playing and the local noise is absent, can be averaged to obtain an estimate of the specific MNL. If the local noise is continuous, then the $L_{Aeq\ T}$ without the music can be taken and a correction made when the music is playing.
- A-weighted readings place less emphasis on low frequencies, and consequently complaints about bass noise emissions may arise even if MNL limits are not exceeded. The *Code of practice* does not specify limits for low frequency noise but does suggest guidelines that may help to estimate its intrusiveness. It is important to be aware, however, that low frequency sound can fluctuate significantly and can be extremely difficult to measure, and therefore significant levels of uncertainty should be expected.
- It should be borne in mind that due to topographical and meteorological conditions, residents further away from the venue may be more exposed to music noise than those closer to the concert.
- Compliance with the *Code of practice* may not eliminate all complaints, and local factors may affect the likelihood of complaints even if MNL limits are not exceeded.
- Noise assessors undertaking concert/festival work should be suitably competent.

Setting limits

The recommended limits for concerts and sound checks held in different locations and categories of venues are clearly set out in the *Code of practice*. Absolute limits for concerts taking place up to three times in a calendar year are given in terms of $L_{Aeq\ 15\ min}$ measured at one metre from the facade of a designated noise sensitive location. When concerts are held more than three times in a year, an exceedance of 15 dB over background levels at a sensitive location is permitted.

For concerts continuing later than 2300 h, the criterion of inaudibility inside a sensitive location is recommended. In order to achieve this, the *Code of practice* suggests that the music should be barely audible at the building's facade.

The authors of the *Code of practice* found that community acceptance can diminish when concerts are held at the same venue for more than three consecutive days, and therefore imposition of lower thresholds may be appropriate in this situation. For a one-off concert, on the other hand, a slightly higher limit may be acceptable.

Sample conditions, which may be useful to a licensing authority, are provided in an appendix to the *Code of practice*.

22. Kennels & dog care centres

Standards & guidance

There are no guidance documents available with respect to barking noise, which is surprising given that a large proportion of complaints received by Irish and UK Local Authorities relate to this source. It is arguable that most conventional guidance is of limited relevance, as barking is impulsive in character, and its impact on listeners is not solely a function of its amplitude (i.e. loudness), but also related to the number of barks occurring during any period. The chief standard used in the assessment of nuisance, BS 4142:2014, specifically precludes itself from application to domestic animal noise.

The AACI is working towards the preparation of a barking noise guidance document. In the interim, Local Authority Officers have no option but to apply suitable conventional guidance such as World Health Organisation criteria discussed in Section 6. A draft guidance document relating to the assessment of barking noise from kennels, issued by Northern Ireland Environmental Health Officers in 2020, is currently being evaluated in the field.

Typical issues

- Barking noise is arguably impulsive. Where barking noise is described using the $L_{Aeq\ T}$ parameter, an impulse penalty rating may therefore be applicable. Such a penalty is not applicable, however, to barking noise L_{AFmax} levels.
- Barking may arise internally throughout the daytime, evening and night-time, and may also arise externally during exercise periods.
- Good kennel design will reduce barking noise impacts, and certain management techniques may also curtail barking. However, some dogs will be prone to barking, regardless of mitigation, and may promote barking across the wider facility. Unless exceptional building design and management techniques can be shown, the Local Authority should expect complaints from any receptors within several hundred metres.
- Larger facilities may generate elevated traffic levels locally during drop-off and collection periods.
- Local Authority Officers reviewing noise reports should be satisfied that the report and assessment were undertaken by suitably qualified personnel.

Setting limits

Pending issue of the AACI barking guidance document, and in the absence of any other guidance, WHO (1999) residential criteria are considered most appropriate. The L_{AFmax} criterion recommended by the WHO with respect to night-time is particularly relevant.

As barking is impulsive, consideration should be given to the application of a penalty, whether the 5 dB penalty recommended in the EPA's NG4 document, or a penalty drawn from BS 4142:2014 (see Table 1 in Section 6). It should be noted that such penalties are applicable only to measured $L_{Aeq\ T}$ values, and are not applicable to L_{AFmax} levels.

Where it occurs, barking is usually most pronounced during drop-off and collection periods. Many kennels set defined drop-off and collection windows in order to minimise periods of intrusion. As part of the planning application process, it may be useful to clarify if such windows are to be applied.

23. Sports & leisure facilities

Standards & guidance

Sports and leisure facilities include swimming pools, gyms and multi-use games areas (MUGAs). As with other commercial facilities, none of these benefit from any sector-specific guidance. As in most cases where noise guidance is absent, the EPA's NG4 document is considered reasonably suitable. The Sport England document *Artificial grass pitch acoustics – Planning implications* (2015) recommends use of WHO criteria.

BS 4142:2014 is considered relevant to the assessment of emissions from onsite sources such as air management systems and pumps. However, the standard precludes itself from application to vocal emissions, such as those from pitches. No guidance exists with respect to such emissions. Music emissions, which may arise at gyms and from outdoor events at sports grounds, may be assessed by reference to music noise guidance (see Sections 20 and 21).

Typical issues

- Emissions arising internally within buildings such as pool complexes and gyms are rarely an issue at surrounding receptors, assuming that the building design incorporates appropriate envelope attenuation.
- External sports grounds typically give rise to elevated vocalisations from participants and spectators. These may occur during evening hours at many facilities. Larger fixtures may give rise to particularly elevated spectator noise. It is difficult, if not impossible to reduce such emissions, and consideration should therefore be given to buffer zones around grounds with viewing stands.
- Facilities incorporating hurling alleys may generate repeated impulsive slaps as balls strike the alley wall.
- Whistles used by referees may be considered intrusive at surrounding receptors.
- Public address systems may give rise to offsite nuisance unless properly designed to eliminate spillage to external areas.

Setting limits

Limits such as those recommended by the EPA NG4 document, and those derived from background levels using BS 4142:2014, may be appropriate for fixed plant sources. WHO limits may also be appropriate.

There are no limits or guidance with respect to player or spectator vocalisations, although WHO criteria have been applied in several UK cases. In any case, measurement of such vocalisations to assess compliance may be impractical, particularly as the facility operator is unlikely to be in a position to mitigate such emissions. Rather than assigning limits with respect to such emissions, it may be more

appropriate to ensure that facilities with external grounds are developed at suitable locations, and subject to the Local Authority's development plan.

24. Shooting

Standards & guidance

The most relevant shooting noise guidance document available is *Clay target shooting: Guidance on the control of noise* (2003), issued by the UK Chartered Institute of Environmental Health (CIEH). The document, which specifically relates to clay target shooting, is based on extensive research undertaken by the UK Building Research Establishment on the effects of shooting on residential properties, and includes practical advice on its measurement, assessment and regulation.

Typical issues

- Separation distance, wind speed and direction, cartridge type, and direction of shooting influence the shooting noise level received at a receptor. Thus measurements over a number of shoot days may need to be considered when assessing impact. Consideration should be given to monitoring conducted over a number of competition shoot days, under varying metrological conditions, rather than an informal shoot arranged by the applicant.
- Calculation of the shooting noise level using the CIEH procedure requires suitable noise equipment and detailed calculations. The Local Authority Officer should be satisfied that any noise assessors involved in compliance work or impact assessment regarding shooting facilities demonstrate the required level of competence.

Setting limits

Guidance is included in the CIEH document in relation to suitable noise limits. When granting planning permission, many UK Local Authorities seek to achieve a ‘mean shooting noise level’ of between 55 and 65 dB for normal/club shooting depending on the circumstances. A higher level for weekday small-scale shooting such as one-to-one tuition may be acceptable. The term ‘mean shooting noise level’ is precisely defined in the CIEH document.

25. Heat pumps & similar plant

Standards & guidance

Under Planning Regulations S.I. No. 83 of 2007, micro-renewables including heat pumps are exempt from planning permission, subject to certain requirements. The Regulations state that 'Noise levels must not exceed 43 dB(A) during normal operation, or in excess of 5 dB(A) above the background noise, whichever is greater, as measured from the nearest neighbouring inhabited dwelling'. If a nearby resident suspects that a heat pump exceeds these levels, they may notify the Local Authority. While the Regulations relate to a number of sources, including small wind turbines and solar panels, heat pumps are the chief focus here due to high uptake rates expected over the coming decade, and due to their potential low frequency noise emissions.

Given the ambition targets set out in the Irish Climate Action Plan (600,000 heat pumps to be installed by 2030), it is likely that heat pumps will be promoted nationally over coming years. It is inevitable that complaints of noise will arise unless the management of noise is incorporated at application, design and installation stage. It is considered that a more comprehensive system of noise controls and information is urgently required on a national level.

Typical issues

- Noise emissions from heat pump systems vary widely, with older systems emitting $L_{Aeq\ T}$ levels around 70 dB at 1 m. Newer systems are significantly quieter, and may contain advanced tonal noise abatement. All pumps are required to display an environmental label which includes the noise emission level.
- Manufacturer and supplier noise data can often represent an ideal installation arrangement, such as in an open area. Noise levels may be higher due to actual installation conditions e.g. if the heat pump is placed close to a gable wall or reflecting facade.
- Heat pumps typically run through the night, when background noise levels are relatively low, in order to avail of lower electricity rates.
- An increasingly evident issue with heat pumps is their potential emission of near constant, low frequency humming. The introduction of these noise sources into otherwise quiet neighbourhoods may give rise to disturbance, even if the noise levels comply with general statutory noise limit values.
- Once a system which generates a hum is in operation, there are few technical measures available to eliminate low-frequency noise. Low frequency hums are audible as a disturbance at the threshold of hearing, between 15 and 90 Hz. It is well established that people have varying hearing sensitivities in this range, so while some are not negatively affected, others may suffer severely from ongoing sleep disturbance and consequent deterioration of physical and mental wellbeing.

- Due to the active promotion of heat pumps without the requirement of planning controls, it is possible that a receptor may be affected by multiple heat pumps in the vicinity. Insufficient information is currently available to predict the cumulative low frequency noise impact from multiple systems installed in residential areas.

Setting limits

The current legislative requirement is that heat pumps and similar units should not give rise to levels above 43 dB(A), or more than 5 dB(A) above background levels, measured at the nearest neighbouring inhabited dwelling. At the very least, an application should be accompanied by an assessment of compliance with these criteria, including measurement of background levels, and prediction of levels at receptors. This assessment should be undertaken by an appropriately qualified person with necessary acoustic expertise.

Irish limits are lenient in comparison with those applied internationally. Night-time limits applicable externally at surrounding receptors are 42 dB(A) in the UK, 35 dB(A) in Germany, 33 dB(A) in Switzerland and 25 dB(A) in Austria. The last three jurisdictions require an assessment of tonality. Installers in these countries are required to use noise calculation tools provided by the relevant authorities. In the absence of any such calculation tools here, it is considered that all heat pump grant applications should include an assessment of noise impacts and compliance with S.I. 83/2007 requirements.

The AACI is currently working towards the development of a cohesive heat pump approach, which will include more effective management of noise at pre-installation stage.

26. Noise affecting proposed residential developments

Standards & guidance

The guidance presented in preceding sections relates to outward impacts i.e. noise impacts from a proposed development which may generate impacts at existing (or proposed) receptors. In contrast, this section relates to noise emissions from existing sources which may affect proposed developments. This typically relates to residential developments which are proposed at sites currently subject to elevated traffic, rail, aircraft or industrial noise.

The assessment of inward impacts is a recent development in Ireland, but is quickly becoming a de riguer part of the planning process for proposed residential developments in noisy locations. As such, no Irish guidance has been issued to date. Many noise assessors and Local Authorities have applied the UK guidance document *ProPG Planning & noise: Professional practice guidance on planning & noise – New residential development* (2017), jointly issued by the Association of Noise Consultants, the Institute of Acoustics and the Chartered Institute of Environmental Health. ProPG provides for good acoustic design through a five step process:

Stage 1: Initial noise risk assessment of the proposed development site.

Stage 2 element 1: Demonstrating a good acoustic design process.

Stage 2 element 2: Observing internal noise level guideline.

Stage 2 element 3: Undertaking an external amenity area noise assessment.

Stage 2 element 4: Consideration of other relevant issues.

ProPG recommends the application of internal noise criteria set out in *British Standard BS 8233:2014 Guidance on sound insulation and noise reduction for buildings* with respect to residential buildings. In the absence of any national guidance, ProPG and BS 8233:2014 are considered the most appropriate guidance documents with respect to inward impact assessments.

Typical issues

- Inward assessments are typically sought for residential developments in areas where existing noise levels are elevated. Such areas are usually identified in strategic noise maps and in noise action plans issued by or on behalf of the Local Authority. Existing noise levels across the development site may be available through previously prepared noise maps. However, such maps are usually prepared using modelled data rather than measured data, and should therefore be treated with caution. Site noise levels should be verified by actual measurements onsite.
- BS 8233:2014 refers to $L_{Aeq\ 16\ h}$ levels with respect to daytime, and $L_{Aeq\ 8\ h}$ levels over night-time hours. Local Authority noise action plans may refer to alternative

indices such as the L_{den} or L_{night}. The various indices are not directly comparable. The noise assessment report should clearly state which indices are applied.

- Measured noise levels onsite are typically used to validate a predictive noise model which determines noise levels received at each façade of each building. These in turn may be used to calculate internal levels in building rooms, and thus the required façade treatment may be determined (i.e. wall insulation, glazing requirements, ventilation control, etc.). The procedure followed, and any calculations, should be clearly set out in the noise assessment report.
- Inward impact assessments should be undertaken by suitably qualified and competent noise assessors

Setting limits

It is a matter for the Local Authority to specify internal noise criteria against which a proposed development may be assessed. These may be set out in the Authority's noise action plan or development plan, or may be taken from BS 8233:2014 or alternative guidance. Ideally, the criteria to be applied in the assessment should be made clear to the applicant prior to any noise assessment being undertaken. To this end, prior consultation with the acoustic assessor and the Local Authority should be facilitated at the earliest opportunity. Early consultation will allow the developer and the assessor to benefit from the Local Authority Officer's local knowledge and expertise. In addition, it will allow the Local Authority's concerns and inputs to be addressed at the earliest possible juncture.

The inward assessment will determine the acoustic specifications for glazing, ventilation and other elements. The Local Authority may choose to include identified requirements in conditions attached to any permission granted.

27. Construction

Standards & guidance

In recent years, it has become common practice to assign limits to the construction phase of a project, particularly at larger sites where construction may continue for several months or years. At facilities regulated by the EPA, the construction phase remains within the remit of Local Authorities.

Noise limits applied to construction works are usually higher than those applied to the commissioned development, as such works are usually short-term. It is generally accepted that listeners are more tolerant of such emissions. It is also noted that construction works are necessary to install mitigation measures that will subsequently benefit environmental emissions such as noise.

The chief guidance document applied in the assessment of construction phase noise impacts is *British Standard BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise* (2014). The standard recommends several construction phase limits, depending on background levels and time of day. Typical daytime limits of 65-70 dB are recommended, based on the $L_{Aeq\ 1\ h}$ parameter.

BS 5228:2009+A1:2014 advocates the effective planning and management of projects so that potentially problematic noise emissions can be identified and anticipated in advance. This approach helps to eliminate and/or reduce excessive noise at the design/planning stage and also assists the designers, developers and site operators to manage residual risks. The intention should be to minimise levels of site noise whilst having due regard to the practicability and economic implications of any proposed control or mitigation measures.

Recommendations are given in the standard for establishing effective liaison between developers, site operators and Local Authorities, and guidance is also given on methods of predicting and measuring noise and assessing its impact on those exposed to it.

In 2014, the National Roads Authority (now Transport Infrastructure Ireland) issued *Good practice guidance for the treatment of noise during the planning of national road schemes*. The document recommends $L_{Aeq\ 1\ h}$ and L_{ASmax} limits for road construction projects. Although specifically applicable only to national road projects, many noise assessments, in the absence of any other Irish guidance, have referenced the NRA criteria in assessing construction phase impacts from other project types, including industrial developments, residential housing developments, etc. The daytime $L_{Aeq\ 1\ h}$ limit recommended by the NRA document is 70 dB, with lower criteria suggested at other times. Application of NRA criteria has become more common in recent years.

Typical issues

- Construction and demolition noise can potentially disturb occupants of nearby properties and/or buildings, e.g. residential, amenity, office premises, etc. Some construction/demolition noise sources may give rise to impulsive and/or tonal noise emissions and during certain phases noise emissions can be intensive. Site work is often carried out in the open, so the potential for noise propagation is greater than when noise is contained within a building fabric.
- One of the primary mitigation measures for noise is to curtail the operations so that excessive early morning, evening and night-time noise emissions do not arise.
- Detailed predictive modelling of construction phase emissions is generally impractical, as noise emissions will vary from day to day, depending on project stage, plant used, working zones, etc. In many cases, the actual equipment required may not be known until works commence. Partially completed structures may screen some sources. Given the variability of construction phase emissions, it may be preferable to divide the construction phase into stages, and to predict worst case scenario noise levels from each stage.
- Modelling is typically done using British Standard BS 5228:2009+A1:2014 methodology. While this model is rather simplistic, it is generally sufficient for most sites. Sites where complicated topography or screening considerations apply may benefit from modelling to ISO 9613-2:1996.
- For modelling purposes, source noise data may be (a) obtained from plant suppliers, (b) measured directly, or (c) taken from sample data included in British Standard BS 5228:2009+A1:2014. All are equally valid. However, any assessment should clearly state which has been applied.
- Certain construction activities such as piling and rock breaking generate impulsive emissions. Rating corrections such as those given in NG4 and BS 4142:2014 are typically not applied to construction projects. It may be more appropriate to assess the impact of such emissions by reference to the L_{ASmax} parameter, and subsequent comparison to NRA criteria.
- All construction projects benefit from preparation of a noise management plan (NMP). A NMP will identify construction methods and plant required, refer to predicted impacts, and will set out specific mitigation measures. The NMP will also detail how such measures will be applied, and who will be responsible for their implementation.
- On larger construction projects, effective consultation and co-operation between developers, site managers/operators, Local Authorities, and good community liaison are of paramount importance to minimise noise impacts and complaints.
- Construction phase noise assessments should be carried out by personnel who meet competency criteria.

Setting limits

Criteria set out in British Standard BS 5228:2009+A1:2014 and/or the NRA's 2014 guidance document are considered most appropriate. Different criteria are recommended in both documents for daytime, evening, night-time and weekend periods.

Rating penalties are not usually specified. Impulsive emissions may be controlled through setting of an L_{ASmax} limit.

Noise limits are typically set to minimise the impact on the occupants of noise-sensitive premises. The convention is that limits are imposed at a point 1 m in front of the most exposed façade of these premises (façade levels).

While construction noise limits are typically set for external and not internal areas, in some cases this can be problematic, (e.g. where part of a building is under construction and other parts are occupied) or where adjoining buildings are severely affected through structure-borne noise. Structure-borne noise is difficult to predict and poses technical challenges for monitoring and regulating. In addition, an external limit may not protect a receiver from its effects.

28. Ground-borne vibration

Overview

Vibration levels may be described by reference to several parameters, including displacement, acceleration, frequency and peak particle velocity (PPV). The last is typically used in environmental assessments, as it correlates well with human perception and structural damage. PPV is measured using a triaxial geophone placed at the receptor using a suitable mounting arrangement. The geophone records PPV levels in each direction (longitudinal, transverse and vertical). The highest of these measured during the survey period is typically reported, in addition to the frequency at which this was measured.

In the same way that an acoustic signal travels through the air, a signal may similarly be propagated through solid structures including the ground. Most activities, including traffic, footfall and door closure, generate structure-borne and ground-borne vibration. However, the magnitude of such vibration is usually miniscule and imperceptible. The chief exceptions to this are blasting (quarries and road projects) and piling. It is worth noting here that rock breaking generally does not give rise to ground-borne vibration beyond 50 m.

A quarry blast is likely to generate ground-borne vibration, in a single transient event immediately after the blast, detectable out to several hundred metres. The magnitude of vibration is linked to the maximum instantaneous charge size. Vibration monitoring is usually carried out at one or more receptor positions during each blast. Charge size and recorded vibration levels are correlated to calculate the scaled distance factor relevant to the quarry and the receptor. With each blast, this factor can be further refined. The scaled distance factor can be used to estimate the magnitude of vibration likely to arise at a receptor depending on the charge size.

It should be noted that vibration levels cannot be accurately predicted, particularly with respect to blasting. For blasting, the conventional approach is to carry out an initial test blast at a quarry. This blast will be small. PPV levels measured nearby during the blast will be used to derived the scaled distance factor for each receptor. This will allow PPV levels to be predicted for subsequent blasts, depending on charge size.

Unlike a quarry blast, piling may generate sustained ground-borne vibration throughout the piling operation. Depending on the piling method, vibration may be negligible, or may be quite perceptible at 100 m or more. The magnitude of vibration at a receptor may be estimated in advance using empirical formulae derived for some piling methods.

Standards & guidance

Several standards and guidance documents exist. *British Standard BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction*

and open sites Part 2: Vibration (2014) includes advice on measurement, control, and suitable limits, particularly in relation to construction projects.

BS 7385:1990 Evaluation and measurement for vibration in buildings Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings (superseded by *BS ISO 4866:2010*) and *BS 7385:1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration* both provide guidance with respect to structures. Criteria listed in these and other standards have been used to form the basis of guidance listed in the following documents.

The EPA document *Environmental management guidelines: Environmental management in the extractive industry (non-scheduled minerals)* (2006) and the Department of the Environment, Heritage & Local Government (DOEHLG) document *Quarries & ancillary activities: Guidelines for planning authorities* (2004) both include recommended PPV limits applicable to blasting.

With respect to piling, the National Roads Authority document *Good practice guidance for the treatment of noise during the planning of national road schemes* (2014) includes recommended PPV criteria.

Setting limits

Criteria variously set out in the documents above are considered the most appropriate.

29. Air overpressure

Overview

Air overpressure (AOP) is an issue solely for blasting. The blasted face generates a transient pressure wave which travels away from the face. The pressure wave is an acoustic wave, identical to a sound pressure wave. However, most of the acoustic energy is typically concentrated at lower frequencies, much of which will be below the frequency detection threshold of the human ear. Consequently, a large proportion of the signal will be 'felt' rather than heard. The pressure wave will often cause windows to vibrate slightly, similar to the window vibration which may occur when a truck passes on an adjacent road.

AOP is highly unlikely to cause structural damage, and there is no evidence that AOP from quarry blasts may cause structural or cosmetic damage. At high AOP levels, the most likely impact will be shattering of windows.

As AOP constitutes an acoustic wave, it is measured in decibels, although without application of the A-weighting. The measured parameter is therefore the dB_{lin}. AOP is usually measured in conjunction with ground-borne vibration during quarry blasts by an instrument connected to an appropriate microphone and triaxial geophone.

AOP cannot be reliably predicted. At a quarry, an experienced shot firer will apply several mitigation techniques to minimise the magnitude of the AOP wave.

Standards & guidance

AOP is discussed in *British Standard BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 2: Vibration* (2014), the EPA document *Environmental management guidelines: Environmental management in the extractive industry (non-scheduled minerals)* (2006), and the DOEHLG document *Quarries & ancillary activities: Guidelines for planning authorities* (2004).

Setting limits

The EPA and DOEHLG documents recommend an AOP criterion of 125 dB_{lin} at receptors, with a 95 % confidence limit.

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Appendix: AACI survey checklist

This summary check list has been prepared to assist in ensuring that noise monitoring reports meet criteria specified in the Environmental Protection Agency document *NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities* (2016). The checklist follows a sequential format typically found in any noise survey report. The checklist has been formulated by the AACI members, drawing from collective experience and observations of noise monitoring and reporting. The checklist may be used for compliance reports relating to planning permission as well as EPA licences.

No.	Description	Yes/No
1	Are conditions of planning, licence or associated authorisation stated at the outset to provide the report scope?	
2	Does the report provide an overview of main noise sources, topography, built environment and location of receptors; - especially relative to the activity being surveyed and other extraneous sources that can dominate? Does the report make reference to the suitability of the monitoring locations in order to adequately assess the activity?	
3	Is a grid reference and photograph provided for each monitoring location to ensure repeatability in the future and is each location adequately described relative to the activity being measured? Has a map been provided showing the monitoring locations? Has adequate distance from reflective surfaces been maintained and if not has the author described the effect? Is each monitoring location (where relevant) representative of the likely experience at the receptor?	
4	Are weather conditions adequately described for different periods of the day, evening, night? Localised weather effects can occur at individual monitoring locations. Wind direction and strength and influence the effects of noise sources. This should be described in the report particularly in the uncertainty section.	
5	Does the report contain the names of the persons who undertook the monitoring and prepared the report? Are their qualifications and experience specific to acoustics and noise assessment been clearly stated? Has an adequate level of both practical and theoretical competency been detailed?	
6	Is the make, model and serial number of each calibrator, microphone and sound level meter quoted?	

Continued over

No.	Description	Yes/No
7	Are there calibration certificates in the report? Is the equipment within calibration to a traceable standard? (1-year calibrator, up to 2 years for SLM)	
8	Has evidence of field calibration and/or drift been provided in the report?	
9	Has the drift between field calibrations been specified and reported in the discussion of uncertainty in the report? Drift should be lower than 0.5 dB.	
10	Has the SLM set-up been reported? e.g. Frequency weighting used (Z or un-weighted) and response time (fast).	
11	Has software been used to analyse and report the data post monitoring? Logged data graphs can provide more clear illustration of where extraneous sources can affect a monitoring location and can clearly show the difference between day and night at some monitoring locations.	
12	Where the $L_{Aeq\ T}$ values are above the limit values, has the author clearly demonstrated if the exceedance is due to the specific noise from the facility or extraneous sources? This can be done simply through the provision of logged data identifying source and extraneous effects and a description of specific noise sources at this location. Contemporaneous notes and observations can also be used by the assessor to explain the findings/assessment.	
13	Has the $L_{A90\ T}$ value been used appropriately? The assessor should use their expertise and judgement to determine the specific noise and their justification for using or extrapolating an $L_{A90\ T}$ value should be explained in the report.	
14	Has a tonal assessment in accordance with the simplified method set out in the guidance been completed for each monitoring location? Where the simplified method is used, has the author provided details on how they excluded the effects of dominant extraneous sources i.e. such as the use of percentile spectra and/or short term sampling?	
15	Have intermittent tones been identified?	
16	Have impulsive sources been adequately identified?	
17	Has the author demonstrated their experience and knowledge where a subjective assessment of tones and/or impulsive sources has been provided?	
18	Does the report provide a comparison of current and historical results?	
19	Does the report include the un-weighted frequency analysis at each monitoring location in tabulated format?	
20	Does the report provide an adequate discussion of findings at each monitoring location, uncertainty analysis and conclusions with regard to compliance?	