



Environmental Protection Agency  
Office of Environmental Enforcement (OEE)

**Guidance Note for Noise:  
Licence Applications, Surveys and  
Assessments in Relation to  
Scheduled Activities (NG4)**

January 2016

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## **Supersession**

This document supersedes the following Agency publications, which are withdrawn with immediate effect:

- *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)* (April 2012)
- *Guidance Note For Noise In Relation To Scheduled Activities* (2<sup>nd</sup> Edition, 2006)
- *Environmental Noise Survey Guidance Document* (2003)

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## **EXECUTIVE SUMMARY**

This document is intended to assist licensed sites with the assessment of their potential and actual noise impact on the local environment. It provides the relevant knowledge and guidance to licensees together with their consultants, regulators and interested third parties.

The Agency has previously issued three documents in relation to the assessment and management of noise emissions from licensed facilities, namely the *Environmental Noise Survey Guidance Document*<sup>1</sup> (commonly referred to as NG1), *Guidance Note For Noise In Relation To Scheduled Activities – 2<sup>nd</sup> Edition*<sup>2</sup> (commonly referred to as NG2) and *Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites*<sup>3</sup> (NG3). It has been decided to amalgamate NG1 and NG2 into one document, designated NG4, for ease of reference and to avoid repetition and confusion which may occur with the use of two separate documents. These two earlier noise guidance notes (NG1, NG2) are now withdrawn with immediate effect.

This amalgamated document has been updated to provide clear guidance in relation to the following:

- A background to the basic theory of environmental noise;
- A discussion of the principle of Best Available Techniques (BAT);
- Outline guidance on noise reduction measures that may be considered in certain instances, and;
- Discussion of licensed sites in the context of the Environmental Noise Regulations.

This document also provides procedures and assessments that should be undertaken in order to present the following to the Agency:

- A robust and sufficiently detailed Integrated Pollution Prevention and Control/Waste Licence application in terms of noise;
- Applicable noise criteria for the site in question, with due consideration of the existing noise environment in the absence of the development;
- A sufficiently detailed annual noise survey for inclusion within Annual Environmental Reports (including appropriate assessment and discussion of measured noise levels), and;
- Recommended assessment procedures for impulsive and tonal noise (if present).

Other key changes and additions arising in this document may be summarised as follows:

- Assessment periods are now expressed in terms of day, evening and night as opposed to day and night only, and;
- Recommended minimum durations for environmental noise surveys.

The January 2016 update of this document provides additional information and clarifications as follows:

- Updated guidance to reflect the publication of BS 4142: 2014;
- Examples of circumstances where it may be appropriate to use detailed reference methods for the assessment of tonality and impulsivity;
- Clarification of environmental noise survey durations and sample periods;
- Guidance on the use of  $L_{AF90}$  in instances where extraneous noise sources may have an influence on measured  $L_{Aeq}$  values, and;
- Inclusion of clarifications as required in light of queries addressed in the relevant FAQ document.

## PREFACE

### Introduction to the Environmental Protection Agency

The Environmental Protection Agency (the Agency) administers a wide range of licensing, enforcement, assessment and monitoring activities. The Office of Environmental Enforcement (OEE), which operates under the control and direction of the Board of the EPA, is dedicated to the implementation and enforcement of environmental legislation in Ireland.

The OEE's main functions are to:

- Improve overall compliance with environmental protection legislation;
- Raise awareness about the importance of enforcement of environmental protection legislation;
- Enforce Integrated Pollution Prevention and Control (IPPC) Licences, Waste Licences and Waste Water Discharge Licences;
- Audit and report on the performance of local authorities in their environmental protection functions, including:
  - Prosecute, or assist local authorities to prosecute, significant breaches of environmental protection legislation, in a timely manner, and;
  - Assist local authorities to improve their environmental protection performance on a case by case basis, through establishing an enforcement network to promote information exchange and best practice, and by providing guidance.

The OEE approach seeks to provide information and advice via guidance to those it regulates to ensure environmental improvements whilst ensuring value for money<sup>4</sup>.

### Noise Guidance Notes

The Agency has published several noise guidance notes to date.

The *Environmental Noise Survey Guidance Document*, 2003 (commonly referred to as NG1), provided advice on conducting a noise survey in accordance with noise conditions laid out in IPPC and Waste Licences. This document is now withdrawn.

A second document, *Guidance Note for Noise in Relation to Scheduled Activities, 2<sup>nd</sup> Edition* (commonly referred to as NG2), was published in 2006<sup>i</sup> providing an update on changes to legislation, licensing requirements and Agency policy. This document is now withdrawn.

A third publication, *Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3)*, was published in June 2011 and deals with development of a standardised noise impact assessment methodology to allow Agency licensed sites to assess the impact of wind energy proposals on noise sensitive locations.

### Purpose and Objectives of this Guidance Note (NG4)

This Guidance Document is designed to provide acoustic guidelines to the operators of activities which are listed in the First Schedule of the *Environmental Protection Agency Act*<sup>5</sup> and the Third and Fourth Schedules of the *Waste Management Act*<sup>6</sup>. Such activities are subject to an IPPC or Waste Licence.

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<sup>i</sup> The original *Guidance Note for Noise in Relation to Scheduled Activities*, which was published by the Agency in 1995, was designed to provide general acoustic guidance for licensed activities. The 2<sup>nd</sup> edition was updated to reflect certain legislative changes since 1995 and also took cognisance of developments in Agency policy and licensing requirements over the intervening years.

As part of the IPPC and Waste Licensing systems, certain scheduled activities and operations have conditions attached to their licences which effect control over emissions of noise. Noise control measures and limits are generally stipulated by specific licensing conditions. Limits may be imposed at boundary positions and/or at noise sensitive locations. In addition, certain limits may be applied to specific sources of noise on-site. Typically licence conditions also place restrictions on tonal and impulsive characteristics associated with noise emissions from licensed facilities. As part of this guidance, specific procedures for the assessment of tonal and/or impulsive emissions are set out.

The principle of Best Available Techniques (BAT) should be employed to control noise emissions from all licensed activities. Whilst this guidance note does not constitute a statement of BAT for noise, it does deal in general terms with the approach to be taken in the regulation, assessment and control of noise from the relevant activities.

This note sets out some of the basic concepts of noise and outlines the limits that should typically be met by existing licensed facilities. Guidance is provided for sites undertaking new IPPC/Waste Licence applications for the derivation of appropriate noise conditions, such that the existing noise environment in the absence of the development is considered. Techniques used for the control of noise are addressed briefly and references are made to other sources of information on this topic.

The wording of a typical licence condition relating to an Annual Noise Survey should now be interpreted to read as follows:

*'The licensee shall carry out a noise survey of the site operations annually. The survey programme shall be undertaken in accordance with the methodology specified in the Agency publication Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4).'*

In certain circumstances, a licence may specifically state that the licensee is required to consult with the Agency in connection with the timing, nature and extent of the survey.

It is recognised that environmental noise monitoring and assessment can, in certain instances, be both technically demanding and complex. This guidance sets out the Agency's requirements with regard to Annual Noise Surveys, and outlines survey and assessment methodologies which fulfil the general licensing requirements with regard to noise. In particularly complex situations the Agency would advise the applicant to raise such issues as part of any pre-application meetings.

The findings of an Annual Noise Survey need to be presented in a detailed report, and the recommended content of such reports has been addressed in this document. A checklist for drafting such reports is also included.

Occupational exposure to noise is not dealt with in this guidance note, and is dealt with specifically by the Health & Safety Authority (HSA).

This guidance should be read in conjunction with the Agency's Notes on Licence Applications.

This guidance note should not be considered as a legal document.

**Highlighted terms** throughout the text are provided with definitions in the Glossary (Appendix I).

## **Acoustic Terminology**

During the consultation process for this document, a debate arose regarding the correct usage of acoustic terminology. In particular, given the commonly accepted definition of noise as “unwanted sound”, would it be more appropriate to refer to “sound levels” or even “soundscapes”? Whilst the Agency can see the merit in this approach, it is considered that such a change in terminology could give rise to confusion as it would be out of step with current practice across most of the acoustics industry in Ireland. Furthermore, it is arguable that the main thrust of this document, targeted as it is at industrial activity, does indeed relate to “noise” as defined above. It has therefore been decided to retain the same acoustic terminology that has been employed in previous guidance notes.

## **Applicability of this Document**

Note that the guidance within this document relates to the assessment and measurement of noise in relation to Agency scheduled activities only. The guidance does not relate to construction and/or off-site transportation noise. For any construction related noise, this process is generally covered by the conditions of the planning permission and it does not relate to the licensable activity on site. For transportation noise, the noise from trucks and forklifts etc. would only be relevant where they are operating within the site boundary as they are then connected with the licensable activity, for example, loading and unloading of materials/goods. All off-site transportation activities and construction related issues are typically covered in other guidance documents and best practice standards (see Section 11). In other instances, a competent person should be retained to develop a suitably robust noise assessment protocol for the issue in question.

## **Revision of Document**

This guidance note may be subject to review or amendment. The Agency website ([www.epa.ie](http://www.epa.ie)) will maintain the most up to date version of this guidance note. Please contact [info@epa.ie](mailto:info@epa.ie) with any queries.



## 1. INTRODUCTION

This guidance note has been developed and written for a wide range of users, including site licensees, regulators, Agency Inspectors, acoustics professionals, planners and interested third parties. Figure 1 identifies which sections are of most relevance to each user. It is, however, recommended that the entire document is reviewed to ensure a comprehensive understanding of the **noise** issues in question.

### 1.1 Description of Guidance Note Sections

- Section 2      Competent Person** – Outlines the minimum requirements/experience that should be clearly demonstrated by a competent person completing the noise section of a licence application or carrying out annual noise surveys, etc.
- Section 3      Noise Fundamentals** – Provides the lay reader with an introduction into the basic principles of acoustics in order to assist with the interpretation of some of the more technical aspects of the document.
- Section 4      Noise Criteria** – Outlines a detailed approach to be followed by a site applying for an IPPC or Waste Licence in relation to identifying and applying appropriate noise criteria to the facility.
- Section 5      Assessment of Tonal & Impulsive Noise** – This section presents standardised approaches for the assessment of tonal and impulsive noise emissions.
- Section 6      Noise Inputs into IPPC/Waste Licensing Applications** – Presents additional guidance to supplement the information contained within the relevant application forms and *IPPC Licensing Application Guidance Notes*<sup>7</sup> and *Waste Licensing Application Guidance Notes*<sup>8</sup>. It expands on guidance in relation to the level of detail and information that should be submitted as part of the licensing process.
- Section 7      Environmental Noise Surveys** – Deals with issues that need to be considered by the competent person in relation to carrying out noise survey work associated with IPPC and Waste Licence sites. Whilst not exhaustive, the section covers issues such as minimum monitoring periods, equipment, calibration, weather and information to be contained within annual noise reports.
- Section 8      Noise Control & Mitigation Measures** – Presents an overview of the implementation of noise management plans and a high level discussion of options for noise control and mitigation. This section provides interested parties with a rounded introduction to the noise control and mitigation options that may be considered in relation to licensed sites. Noise mitigation measures necessary for specific situations will require the attention of a suitable competent person.
- Section 9      Complaint Investigation** – Presents some advice to the licensee as to the extent of information that should be obtained in order to facilitate the prompt and robust investigation of noise complaints received from third parties.
- Section 10     Specific Activities** – Reviews other aspects and operations that the Agency has a level of jurisdiction over, and outlines other publications that are applicable to them. This section also presents some guidance in relation to other assessment approaches that may be worth considering in relation to noise assessments that do not fall under the remit of the Agency.
- Section 11     Other Guidance** – This section provides information on a variety of documents that may be of assistance in the assessment of noise in relation to operations and activities that do not fall under the remit of the Agency.

**Figure 1 Quick Reference to Guidance Note NG4**

Section	Guidance Note Chapter	Guidance Note Relevance
1.	Introduction	All Users
2.	Competent Person	Licensees / Acoustic Engineers
3.	Noise Fundamentals	All Users
4.	Noise Criteria	Licensees / Acoustic Engineers
5.	Assessment of Tonal & Impulsive Noise	Licensees / Acoustic Engineers
6.	Noise Inputs into IPPC / Waste Licensing Applications	Licensees / Acoustic Engineers
7.	Environmental Noise Surveys	Licensees / Acoustic Engineers
8.	Noise Control & Mitigation Measures	All Users
9.	Complaint Investigation	Licensees / Acoustic Engineers
10.	Specific Activities	All Users
11.	Other Guidance	All Users

## 1.2 Noise Conditions in EPA Licences

It is a requirement of the Environmental Protection Agency to ensure that relevant licensed activities do not result in significant impact on the environment; this includes noise impact on the human environment. IPPC and Waste Licences typically contain several conditions in relation to noise, including: separate daytime and night-time noise limits, monitoring/reporting protocols and site specific noise monitoring locations. It is the responsibility of each licensee to ensure that the site is compliant with these conditions and does not have a detrimental effect on the local noise climate. IPPC and Waste licences may also contain conditions to control site noise and the resultant noise impact. The overriding objective is to licence sites, monitor emissions and control or mitigate the noise impact at **noise sensitive locations** (NSL's), if necessary.

The previous guidance set out by the Agency in *Guidance Note for Noise in Relation to Scheduled Activities, 2<sup>nd</sup> Edition* outlined daytime and night-time noise limits, which were typically adopted in relation to the majority of licensed sites. Whilst it was clearly stated that existing background noise levels in the vicinity of a proposed site should be considered in the formulation of appropriate noise limits, this approach was rarely adopted in practice and the generic noise criteria were usually applied. This revised guidance sets out clear methodologies for the derivation of appropriate noise criteria, which should be adopted in the case of all new licence applications. In situations where existing licences are in place, the noise conditions therein should be reviewed on a case by case basis at times when such licences are up for review. It is acknowledged that retention of the existing daytime and night-time periods and criteria may be appropriate in certain cases, for example, in situations where a site has been operating successfully for a significant period of time without any history of noise complaints.

To date, environmental noise limits have typically been stated over daytime and night-time periods only. Noise from licensed facilities will henceforth be assessed over three distinct periods, i.e. daytime, evening, and night-time<sup>ii</sup>.

## 1.3 Statutory Framework

BAT was formally introduced into the EU legislative framework for IPPC and certain Waste Management activities under the *IPPC Directive 96/61 EC*<sup>9</sup>. The Directive's provisions have been transposed into national law in Ireland by the *Protection of the Environment Act*<sup>10</sup>.

While the *EPA Act* and the *Waste Management Acts* required the use of BATNEEC (Best Available Technology Not Entailing Excessive Costs) to prevent, eliminate, limit, or abate emissions, best practice now requires the use of Best Available Techniques (BAT).

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<sup>ii</sup> It is considered that this approach facilitates an enhanced level of environmental protection, whilst also aligning the approach with that set out within the *Environmental Noise Regulations*. This consistency will enable agglomeration noise mapping bodies to use the IPPC Licence information as a screening study in order to determine whether mapping of industrial noise sources is required. For example, if measurements at IPPC/Waste Licensed sites demonstrate that no NSL's are exposed above the relevant reporting thresholds, then strategic noise mapping is not required, as there is no noise exposure to assess. Note that the *Environmental Noise Regulations* are not applicable to industrial premises located outside of defined agglomerations.

## 1.4 Best Available Techniques (BAT)

BAT is defined in Section 7 of the *Protection of the Environment Act* as follows:

*'...the most effective and advanced stage in the development of an activity and its methods of operation which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission limit values designed to prevent or eliminate or, where that is not practicable, generally to reduce an emission and its impact on the environment as a whole'.*

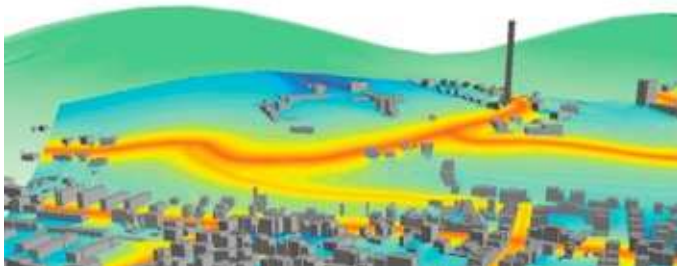
In this context 'best' means 'the most effective in achieving a high general level of protection of the environment as a whole'.

The expression 'available techniques' means 'those techniques developed on a scale which allows implementation...., under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the operator carrying on the activity'.

The term 'techniques' includes 'both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned'.

In specifying or otherwise determining BAT, Section 7 of the *Protection of the Environment Act* requires the Agency to have regard to a specified list of considerations and also to 'the likely costs and advantages of measures' as well as 'the principles of precaution and prevention'.

Thus, the concept of BAT requires a degree of balance between the attainment of environmental benefits and the likely cost implications for the licensee. In the identification of BAT, regard should be had to a wide range of factors, however, emphasis should be given to 'practical suitability' and the need 'to reduce an emission and its impact on the environment as a whole'.



In determining BAT, applicants for IPPC and Waste Management Licences must have regard to the relevant BAT Guidance Notes which are published by the Agency. These BAT Guidance Notes are periodically reviewed and updated and applicants should be satisfied that the latest version has been consulted. In addition, other useful guidance documents include the BAT Reference (BREF)

documents which are published by the European Commission and the draft Agency guidance published for the Waste Management Sector in April 2003.

Generally a determination of BAT will involve a comparison of the techniques that prevent or reduce emissions, and identifying the best techniques in terms of those which have the lowest impact on the environment. Alternatives should be compared both in terms of the primary production or process techniques and the secondary treatment or abatement techniques. Once the practical options have been identified, these should be assessed by focusing upon the significant environmental effects, both direct and indirect.

While assessments should identify and quantify possible releases of polluting substances into all media, they should also quantify their likely effects. Most attention should be paid to large-scale releases and releases of the more hazardous pollutants. With specific reference to noise emissions, detailed assessments are warranted if a preliminary assessment, or operational history, indicates that significant effects are likely.

Technologies identified in the BAT Guidance Notes are considered to be representative of current best practice at the time of writing. However, the Agency encourages the development and

introduction of new and innovative technologies which meet BAT criteria. In addition, the Agency looks for continuous improvement in the overall environmental performance of waste sector and IPPC activities. All operators should therefore continue to keep up to date with the best available technologies relevant to the activity.

At the operational and site-specific level, the most appropriate techniques will depend on local factors. A local assessment of the costs and benefits of the available options may be warranted to establish the best option. The choice of techniques may be influenced by factors such as; the technical characteristics of the facility, geographical location or other local environmental considerations. Individual company profitability, however, is not a relevant consideration.

To demonstrate that BAT is being applied, consideration must be given to measures that can be taken to reduce or eliminate emissions (including noise) from the licensed facility.

While technologies identified in the Agency's BATNEEC Guidance Notes are representative of currently employed techniques, this does not preclude the use of any other similar technology or technique that may achieve the required emission standards.

While the concept of BAT does permit a distinction to be made between new and pre-existing facilities, it is envisaged that all pre-existing facilities will progress towards the attainment of similar environmental standards and controls to those which pertain to new facilities. However, with regard to pre-existing facilities, specific requirements and associated time frames for their attainment will be identified on a case by case basis when a licence application or licence review application is being processed.

The following considerations should always be taken into account for pre-existing facilities:

- The nature, extent and effect of the emission concerned;
- The nature and age of the existing facilities connected with the activity and the period during which the facilities are likely to be used or to continue in operation, and;
- Whether a disproportionate cost would be incurred to replace the old plant with the new techniques for only a small reduction in emissions.

In considering the actual emissions, regard should be had to sensitive receptors and local environmental impacts and a risk-based approach should be adopted to establish the extent of hazards and identify appropriate controls.

## 1.5 Environmental Noise Regulations

The *Environmental Noise Regulations*<sup>11</sup> transpose into Irish law EU Directive 2002/49/EC<sup>12</sup> relating to the assessment and management of environmental noise, which is commonly referred to as the Environmental Noise Directive or END. The END defines a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise.

To that end a three stage process is set out:

- Undertake strategic noise mapping to determine exposure to environmental noise;
- Ensure information on environmental noise and its effects is made available to the public, and;
- Adopt action plans, based upon the noise mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good.

The END is predominantly concerned with long term exposure to noise from transport infrastructure and certain industry. Noise from industrial sites only falls within the scope of the

END inside large urban areas, known as agglomerations, of more than 100,000 inhabitants. Currently there are two agglomerations in Ireland defined within the Environmental Noise Regulations. These agglomerations are Dublin and Cork. Outside of these two agglomerations industrial noise does not fall within the scope of the *Environmental Noise Regulations* or END.

Within the two agglomerations, industrial noise from IPPC licensed sites falls within the scope of the *Environmental Noise Regulations*. The strategic noise maps and noise action plans for the agglomerations need to include the assessment and control of noise from IPPC licensed industrial sites if the noise emitted by such sites exceeds the thresholds which are to be reported to the public and EC, currently 55dB  $L_{den}$  and 50 dB  $L_{night}$ . Strategic noise maps and noise action plans are reviewed and revised on a five yearly cycle, with each cycle to report on changes in environmental noise and outcomes from measures within noise action plans. It is the responsibility of the designated local authorities to draw up strategic noise maps and noise action plans.

It is important to note that the *Environmental Noise Regulations* specifically set out a new process by which noise from IPPC licensed industrial sites within agglomerations is to be mapped, published and strategically managed. The Environmental Noise Regulations do not, however, introduce a new mechanism by which the aims of the noise action plans may be delivered. For example, should an IPPC licensed industry within an agglomeration have a noise emission above the reporting thresholds, any proposed reduction in noise emission within the noise action plan drawn up by the local authorities would be facilitated via amendment of the IPPC licensing conditions relating to noise, which are drawn up by the Agency.

It can be seen that the IPPC regulations set out a licensing program by which noise from industrial sites may be controlled as necessary, whilst the *Environmental Noise Regulations* set out a strategic management framework that operates above this and which involves the local authorities and public as stakeholders. The strategic noise maps publish information on industrial noise emissions within agglomerations on a consistent basis, whilst the noise action plans enable the local authorities and public to be involved in setting long term aims and objectives for noise control.

In support of its role as national competent authority, the Agency has published two Guidance Notes related to the *Environmental Noise Regulations* which set out further practical information on implementation of the END in Ireland:

- *Guidance Note for Strategic Noise Mapping*<sup>13</sup>; and
- *Guidance Note for Noise Action Planning*<sup>14</sup>.

These guidance notes may be subject to review or amendment. The Agency website ([www.epa.ie](http://www.epa.ie)) will maintain the most up to date versions of these guidance notes.



## 2. COMPETENT PERSON

The person (or persons) responsible for the technical aspects of noise assessments in accordance with this guidance note must comply with the definition of a '**competent** person'. This applies to all aspects of the assessment, i.e. survey work, data processing, reporting, noise modelling and noise control.

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 and experience of relevant acoustical standards, e.g. ISO 1996<sup>15</sup>, ISO 9613<sup>16</sup> and BS 4142<sup>17</sup>;
- A clear understanding of the licensing obligations with regard to noise;
- Familiarity with acoustical monitoring equipment and with a range of noise indices including: **L<sub>AFN</sub>**, **L<sub>AFmax</sub>**, **L<sub>Aeq,T</sub>**, and **L<sub>Ar,T</sub>**;
- Familiarity with acoustic software such as that used for the analysis of survey data and noise modelling;
- Practical knowledge and experience of spectrum analysis – **octave band** and **1/3 octave band** analysis and an ability to assess **tonal** and **impulsive** elements;
- An ability to analyse, interpret and explain results;
- An ability to perform necessary acoustic calculations where appropriate, and;
- An ability to recognise when more specialist expertise may be needed.



A competent person needs to demonstrate both practical and theoretical competence and should participate in continual professional development. Competence may be demonstrated through reference to an appropriate qualification and/or professional membership of a recognised acoustic organisation (e.g. the Institute of Acoustics) and/or appropriate experience.

Note that, particularly in the case of those sites with a large number of monitoring locations, it will be acceptable for survey work to be conducted by junior staff under the supervision of senior colleagues, provided that the junior staff can demonstrate a level of competence that is commensurate with the level of work being undertaken.

### 3. NOISE FUNDAMENTALS

Noise is regarded as a form of manmade pollution and under the *Environmental Protection Agency Act*, the definition of 'environmental pollution' includes 'noise... which is a nuisance or would endanger human health or damage property or harm the environment'. The *Protection of the Environment Act* likewise includes noise in the definition of environmental pollution which encompasses 'the introduction to an environmental medium ... noise which might be harmful to human health or the quality of the environment...'.

In a modern post-industrial society, some form of noise is an almost ubiquitous by-product of many normal everyday activities. Whether the noise is considered as impacting upon health or quality of life, or indeed gives rise to annoyance, depends not just upon the level of noise but also the human reaction to it, whether this be sub-conscious physiological reactions or conscious reactions such as annoyance. Conscious reactions, such as annoyance, most often occur when the noise could be considered unwanted, due to the level, the location, character, the time of day, or interference with other activities.

In the international context it is recognised that, in many urban and industrialised areas, the general population is increasingly exposed to environmental noise. In addition, the health effects of this exposure are considered to be an increasingly important public health problem.

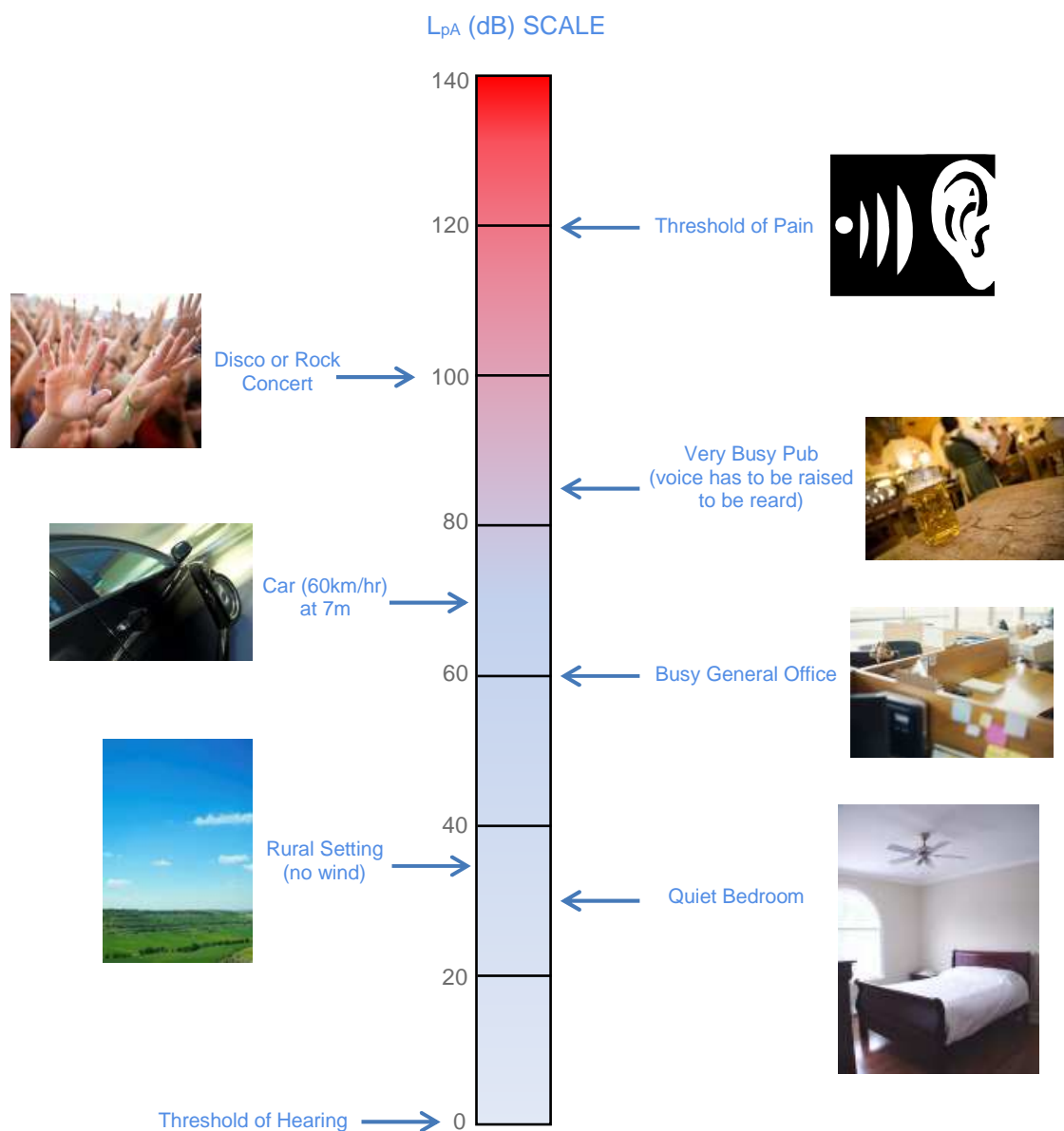
At this stage it is considered worthwhile to outline some key fundamentals of acoustics in order that the lay reader gains a sufficient awareness of them to assist in their understanding of the more technical aspects of this document.

Simply put, sound may be described as a variation in atmospheric pressure that is detected by the human ear and results in the sensation of hearing. Sound propagates at different speeds in different media. For example, in dry air at 20°C, sound propagates at approximately 343m/s, and in water at 20°C, sound propagates at approximately 1,482m/s. The human ear is a very sensitive anatomical organ and can detect a wide range of fluctuations in pressure levels, from the quietest whisper to a jet engine take off. In order to represent this range of detectable pressure changes in a more efficient manner, sound is typically measured in terms of a logarithmic ratio of sound pressures. These values are expressed as **Sound Pressure Levels (SPL)** in decibels (**dB**).

In terms of sound pressure levels, audible sound ranges from 0dB (i.e. the threshold of hearing) to the threshold of pain at 120dB. A doubling/halving of pressure equates to a 3dB increase/decrease in decibel level. Typically, under normal circumstances, a 3dB change in environmental noise level is the smallest noticeable to the human ear. A 10dB increase/decrease in sound level normally equates to a subjective doubling/halving of noise.

The frequency of sound is the rate at which a sound wave oscillates, and is expressed in **Hertz (Hz)**. Human hearing is less sensitive at very low and very high frequencies, that is to say it is not uniform across the sound spectrum. In order to account for this weighting, filters are commonly applied when measuring and/or assessing sound. The most common frequency weighting in current use is 'A-weighting'. This weighting mechanism conforms approximately to the response of the human ear at moderate levels. SPL's measured using 'A-weighting' are expressed as **L<sub>pA</sub> (dB)**. An indication of the level of some common sounds on the L<sub>pA</sub> (dB) scale is presented in Figure 2.



**Figure 2**  **$L_{pA}$  (dB) Scale and Indicative Noise Levels**

Noise levels can be represented using a variety of parameters and weightings. In terms of this document the reader should be aware of  $L_{Aeq,T}$ ,  $L_{AFmax}$  and  $L_{AF90}$  parameters as a minimum. Detailed definitions are presented in the glossary.

## 4. NOISE CRITERIA

When preparing an IPPC or Waste Licence application it is considered that one of the most important aspects of the noise section should relate to the proposal and justification of suitable **criteria noise levels** that will apply to the operation in question. This section of the guidance document outlines the pertinent factors that should be considered when undertaking this procedure and provides a simple scoping process to arrive at suitable noise criteria. It is considered that the guidance outlined here will be appropriate for the majority of situations that the content of this document applies to, however, in certain instances an alternative approach may be considered. In these cases the Agency will consider each application on its own merits following review of any detailed acoustic assessments and associated discussion put forward.

### 4.1 Pertinent Factors in Determining Noise Controls and Limits

The primary objective of this Guidance Note is to provide some practical information and advice in respect of those activities that are listed in the First Schedule to the *Environmental Protection Agency Acts* of 1992 and 2003 and the Third and Fourth Schedules to the *Waste Management Acts* of 1996 and 2003. While the Guidance Note deals in general terms with the approach to be taken in the assessment and control of noise, it does not purport to be a statement of BAT with respect to the noise emissions from these activities. BAT should be employed in problem solving in the area of noise associated with all scheduled activities.

BAT guidance documents normally specify a range of Environmental Quality Standards (EQS's) which are designed to limit the concentration of pollutants in specified environmental media to a definitive quantitative level. Noise is unlike many other pollutants, however, in that there is typically no residual effect and once the noise emission ceases, the acoustical energy attributable to it is eliminated until the emission recommences. Noise is also different in that its potential impact is dependent on a wide range of factors such as:

- The subjective loudness/the measured sound pressure level;
- The sensitivity of any individuals affected;
- The time and duration of emission;
- The nature of the source;
- The location of noise sensitive receptors;
- The **ambient** and **background** noise levels;
- The nature and character of the locality, and;
- The presence or otherwise of special acoustic characteristics such as tones and/or impulsive elements.

The generation of excessive noise in the community can have undesirable effects on the population. Noise is liable to give rise to complaints whenever the level exceeds the pre-existing level by a certain margin or whenever it exceeds certain absolute values.

Noise can cause annoyance and disturbance to people at work or during leisure activities. It can also cause sleep disturbance and have a deleterious effect on general physical and mental wellbeing. People are not equally sensitive to noise, and likewise one person is not equally sensitive to noise at all times of the day or days of the week.

The application of controls and limits should seek to minimise the amount of noise to which people in NSL's are exposed. Examples of such locations include dwellings, hospitals, schools, places of worship and areas of high amenity. A more complete definition of the term NSL is often given in licences and a typical definition is given in Appendix I.

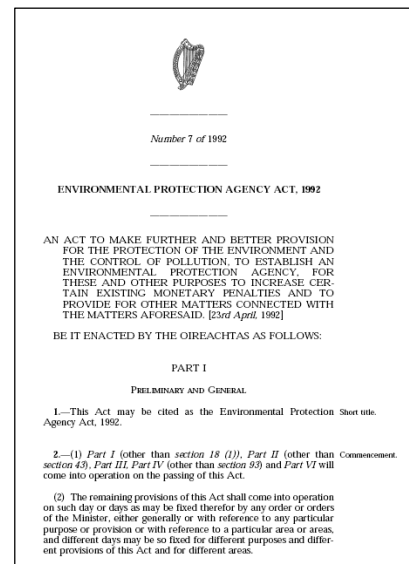
## 4.2 Noise Guidance, Standards and Legislation

Existing legislation relating to noise in Ireland provides for the strategic control of environmental noise from major infrastructure and industry while also providing for control of noise at specific sources and the method in which noise nuisance can be tackled.

The strategic control of environmental noise is directed by the *Environmental Noise Regulations*, which transposed *EU Directive 2002/49/EC*. This Directive was developed to provide a common framework to avoid, prevent, or reduce the harmful effects of environmental noise. The regulations focus on the process for addressing environmental noise from major infrastructure such as airports, major roads, and large agglomerations. Environmental noise from IPPC sites within agglomerations also falls under these regulations. These regulations provide for the generation of strategic noise maps and action plans to reduce the effects of environmental noise, where necessary. Further details including the relationship with IPPC licensing may be found in Section 1.5 above.

Sections 106 to 108 of the *Environmental Protection Agency Act* deal with noise on a smaller (i.e. more local) scale:

- Section 106 deals with control of environmental noise by the Minister and the Agency;
- Section 107 sets out the powers prescribed by the Act to a local authority or the Agency to prevent or limit noise. It typically relates to noise from sites regulated by the Agency or a local authority. This allows local authorities or the Agency to serve notices on premises/sites where prevention or limitation of noise is required. The *Environmental Protection Agency Act 1992 (Noise) Regulations 1994*<sup>18</sup> provide for a prosecution where there is a failure to comply with the requirements of the issued notice, and;
- Section 108 describes the provisions for complaints regarding noise nuisance to be taken to the District Court by any person or agency. It allows for any person, local authority or the Agency to make a complaint to the District Court where noise levels are considered to be generating a reasonable cause for annoyance. Where the court finds in favour of a noise nuisance complaint, the person or body responsible for the noise must reduce it to a specific level, to limit it or cease it altogether.



In describing the approach to issues such as noise measurement, prediction and assessment, this document makes reference to a number of other publications; details of some of the key standards are summarized below.

- *ISO 1996-2, Acoustics - Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels* provides general advice on the quantification of environmental noise from various sources and includes a methodology for evaluating and correcting the measured noise level allowing for any tonal content (ISO 1996 - Part 2 Annexes C and D);
- *ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General method of calculation* provides a methodology for the prediction of noise levels in the community where the source **sound power levels** are known;
- *BS 4142: Methods for rating and assessing industrial and commercial sound* describes methods for determining industrial, commercial and background noise levels, and;
- Guidance pertinent to setting of noise limits is available in two World Health Organization (WHO) publications, i.e. *Guideline for Community Noise*<sup>19</sup>, and *Night Noise Guidelines for Europe*<sup>20</sup>.

### 4.3 General Guidance and Limits for Licensed Sites

When an Agency licence includes conditions relating to noise emissions, this would normally entail specified numerical noise limits which are not to be exceeded. These limits may apply to individual sources of noise on the site itself, at the boundary of the site or at the nearest NSL. The setting of noise limits at any or all of these locations may be required, and the assignment of such limits will be decided during the licensing process for the facility.

All reasonably practicable measures should be adopted at licensed facilities to minimise the noise impact of the activity, and BAT should be used in the selection and implementation of appropriate noise mitigation measures and controls. While BAT must be applied on a case by case basis, the noise attributable solely to on-site activities, expressed as a free field value at any NSL, should not generally exceed the values given below.

#### Typical Limit Values for Noise from Licensed Sites

Daytime (07:00 to 19:00hrs) – 55dB  $L_{Ar,T}$ ;  
Evening (19:00 to 23:00hrs) – 50dB  $L_{Ar,T}$ ;  
Night-time (23:00 to 07:00hrs) – 45dB  $L_{Aeq,T}$ .

The  $L_{Ar,T}$  and  $L_{Aeq,T}$  parameters are defined in Appendix I of this document.

In instances where existing licences are in place the noise criteria stated in the licence still stand. If these licences come under review at a future date consideration will be given on a case-by-case basis in relation to changing from the previous approach (i.e. daytime and night-time noise limits) to the approach outlined in this guidance note (i.e. daytime, evening and night-time limits).

During daytime and evening periods rigorous efforts should be made to avoid clearly audible tones and impulsive noise at all sensitive locations. A penalty of 5dB for tonal and/or impulsive elements is to be applied to the daytime and evening measured  $L_{Aeq,T}$  values to determine the appropriate **rating level** ( $L_{Ar,T}$ ). In all cases, an assessment by a competent person will be required.

During the night-time period no tonal or impulsive noise from the facility should be clearly audible or measurable at any NSL. Any uncertainty over the presence of tones or otherwise should be addressed using the methodology set out in Section 5.0.

In addition to the foregoing recommended licence limit values, the noise from the licensed facility shall not be so loud, so continuous, so repeated, of such duration or pitch and it should not occur at such times, as to give reasonable grounds for annoyance. In this regard, for contentious cases, an assessment by a competent person will be required.

In particularly quiet areas, such as remote or rural settings, where the background noise levels are very low, lower noise limits may be more appropriate and this may be reflected in more stringent licence limits being set. Clear guidance on this issue is outlined in Section 4.4 below.

### 4.4 Setting Limits on Noise Emissions

#### 4.4.1 General Comment

Higher limit values may be set at the boundary than at NSL's to reflect the relative proximity to the source of noise on site, and the proximity of the NSL to the site. The boundary of a plant may offer more practical and easier access for subsequent noise monitoring. Typically, limits are set at the boundary for industrial estates, and at the nearest NSL's and receptors for 'one off' developments, and particularly for green field sites. In instances where an industrial site is

applying for an Agency licence and is proposing the implementation of higher noise levels at various points on the boundary of the site, the application should be supported by a sufficiently detailed noise assessment demonstrating that such limits at the boundary will not have a detrimental effect on any NSL beyond the site boundary.

Alternatively, noise limits may be set on individual sources of noise, taking cognisance of the target limit values to be achieved either at the boundary or nearest NSL. This approach would normally only be considered if there were difficulties in attaining reliable noise data at the site boundary or at NSL's. In such circumstances recourse may also be made to the use of noise modelling techniques.

Restrictions on times of operation may be imposed for all or part of the plant, however, this aspect needs to be balanced with the economic and/or logistical impact on the operation of the plant.



In some jurisdictions proactive planning and development policies zone land banks for industrial or residential use. Such an approach permits the use of buffer zones to ensure that incompatible land uses do not encroach upon each other. In certain situations, however, new dwellings may be constructed in close proximity to pre-existing industrial or waste management facilities and this can cause potential difficulties, as many licences specify a noise limit to be achieved at all NSL's. Facility operators should therefore be aware of any future planning in the vicinity of their sites. The existence of a facility prior to the introduction of NSL's into its vicinity does not provide any allowance for non-compliance with appropriate noise limit values.

It is also considered that relevant local authority planning departments should require that parties applying for such one off developments should consider the issue of noise in a robust manner early in the planning process to avoid issues arising once these sites are occupied. This would typically fall under the remit of a competent person.

In some instances, licensed sites will have certain items of emergency equipment (e.g. standby generators) that will only operate in urgent situations (e.g. grid power failure). Depending upon the context, it may be deemed permissible for such items of equipment to give rise to exceedances in the noise criteria/limits during limited testing and emergency operation only. If such equipment is in regular use for any purposes other than intermittent testing, it is subject to the standard limit values for the site.

#### 4.4.2 Setting Appropriate Noise Criteria

The following methodology is recommended for the selection of appropriate noise criteria for licensed operations. This methodology should be followed for all licence applications. The proposed methodology expands upon previous advice to give specific guidance on how to deal with areas with relatively low background noise levels. This methodology only applies to new licence applications as it is considered impractical to attempt to retrospectively apply the approach to existing licensed facilities, although the Agency may stipulate that this approach is to be followed when a licence comes under review.

The following sections outline the steps to be followed in order to derive appropriate noise criteria.

## Step 1 – Quiet Area Screening of the Development Location

The location of the proposed development should be screened in order to determine if it is to be located in or near an area that could be considered a 'Quiet Area' in open country according to the Agency publication *Environmental Quality Objectives - Noise in Quiet Areas*<sup>21</sup>. This will involve determining if the following criteria are satisfied:

- At least 3 km from urban areas with a population >1,000 people;
- At least 10 km from any urban areas with a population >5,000 people;
- At least 15 km from any urban areas with a population >10,000 people;
- At least 3 km from any local industry<sup>iii</sup>;
- At least 10 km from any major industry centre;
- At least 5 km from any National Primary Route, and;
- At least 7.5 km from any Motorway or Dual Carriageway.

A template for this screening process is provided in Appendix II.

If the site does not meet these criteria it is not considered to be a quiet area as per the Agency definition; proceed to Step 2.

In the event that these criteria are satisfied then a very stringent noise criterion may be considered appropriate. The *Environmental Quality Objectives – Noise in Quiet Areas* document proposes that the following criterion be applied to anthropogenic<sup>iv</sup> noise sources in quiet areas:

*'The noise from anthropogenic sources should not be clearly audible at any point within Quiet Areas'.*

In order to comply with this criterion it is necessary to conduct an extensive background noise survey, at a number of locations, over an extended period, under a range of weather conditions, in order to establish existing noise levels. The results of the survey should be analysed to establish the average background noise levels (in terms of  $L_{AF90}$ ) during daytime, evening and night-time periods. The resultant noise criterion applicable to the licensed facility (in terms of either  $L_{Ar,T}$  or  $L_{Aeq,T}$ ) is then derived by subtracting 10dB from the average background noise level during each period.

It should be noted that, in a Quiet Area, it does not necessarily follow that levels of noise within the area will be low. The noise levels in a quiet area will typically have little, if any, contribution from manmade (i.e. anthropogenic) noise sources such as road or rail. However, the noise levels may be elevated due to the natural noises that form the soundscape<sup>v</sup> of the area in question. Also, a quiet area should not be confused with an area of low background noise as these are two distinct and different areas of concern in the context of this document.

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<sup>iii</sup> Local industry is taken to include all sources of noise that may be considered industrial in nature, for example: grain drying facilities, creameries and small factories.

<sup>iv</sup> Relating to or resulting from the influence that humans have on the natural world.

<sup>v</sup> A soundscape is a sound or combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements, and environmental sounds created by humans such as ordinary human activities including conversation or work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.



## Step 2 – Baseline Environmental Noise Survey

Depending on the outcome of the screening conducted in Step 1 there will be different requirements for the environmental noise survey to be undertaken as part of new license applications.

- A. If the screening process identified the development location as a quiet area then it is recommended that long term noise measurements be undertaken. It is recommended that this should involve unattended noise measurement at a minimum of two locations for a period of at least two weeks at each location (measurements should ideally be concurrent). A sufficient number of locations should be monitored in order that a robust picture of all NSL's within the vicinity of a proposed development is obtained and assessed. Weather monitoring should also be conducted at a location representative of the noise survey location. General guidance on how this noise survey should be conducted is outlined in Section 6.1 of this document. A template for a quiet area survey is presented in Appendix III.
- B. If the screening process in Step 1 does not identify a quiet area, then a series of attended noise measurement surveys at the nearest NSL's to the proposed development are to be conducted over day, evening and night-time periods. The noise survey guidance outlined in Section 6.1 will apply. A template for a non-quiet area survey is presented in Appendix IV.

Worked examples for quiet and non-quiet areas survey templates are presented in Appendix V.

## Step 3 – Screen for Areas of Low Background Noise

For all areas not identified as Quiet Areas in Step 1, the existing background noise levels measured during the environmental noise survey<sup>vi</sup> should be examined to determine if they satisfy the following criteria:

- Average Daytime Background Noise Level  $\leq 40\text{dB } L_{AF90}$ , and;
- Average Evening Background Noise Level  $\leq 35\text{dB } L_{AF90}$ , and;
- Average Night-time Background Noise Level  $\leq 30\text{dB } L_{AF90}$ .

Please note that the average background noise level for a specific period is the arithmetic average of the measured  $L_{AF90}$  noise levels during the relevant period. Each measurement location will typically have a different average background noise level. All noise monitoring results and derived averages should be rounded to the nearest whole integer, with 0.5 being rounded up.

If all three of the above criteria are satisfied for any of the measurement locations, then those locations are deemed to be in areas of low background noise, and the reduced noise limits detailed in Step 4 are applicable at those locations.

There may be occasions when, for the same development, some measurement locations are defined as areas of low background noise and some are not. The determination of appropriate noise criteria should be considered for each measurement location in isolation.

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<sup>vi</sup> These measured background noise levels, expressed in terms of the  $L_{AF90}$  indicator, are not to be confused with the license limit values expressed in terms of  $L_{Ar,T}$  or  $L_{Aeq,T}$ .

**Step 4 – Determine Appropriate Noise Criteria**

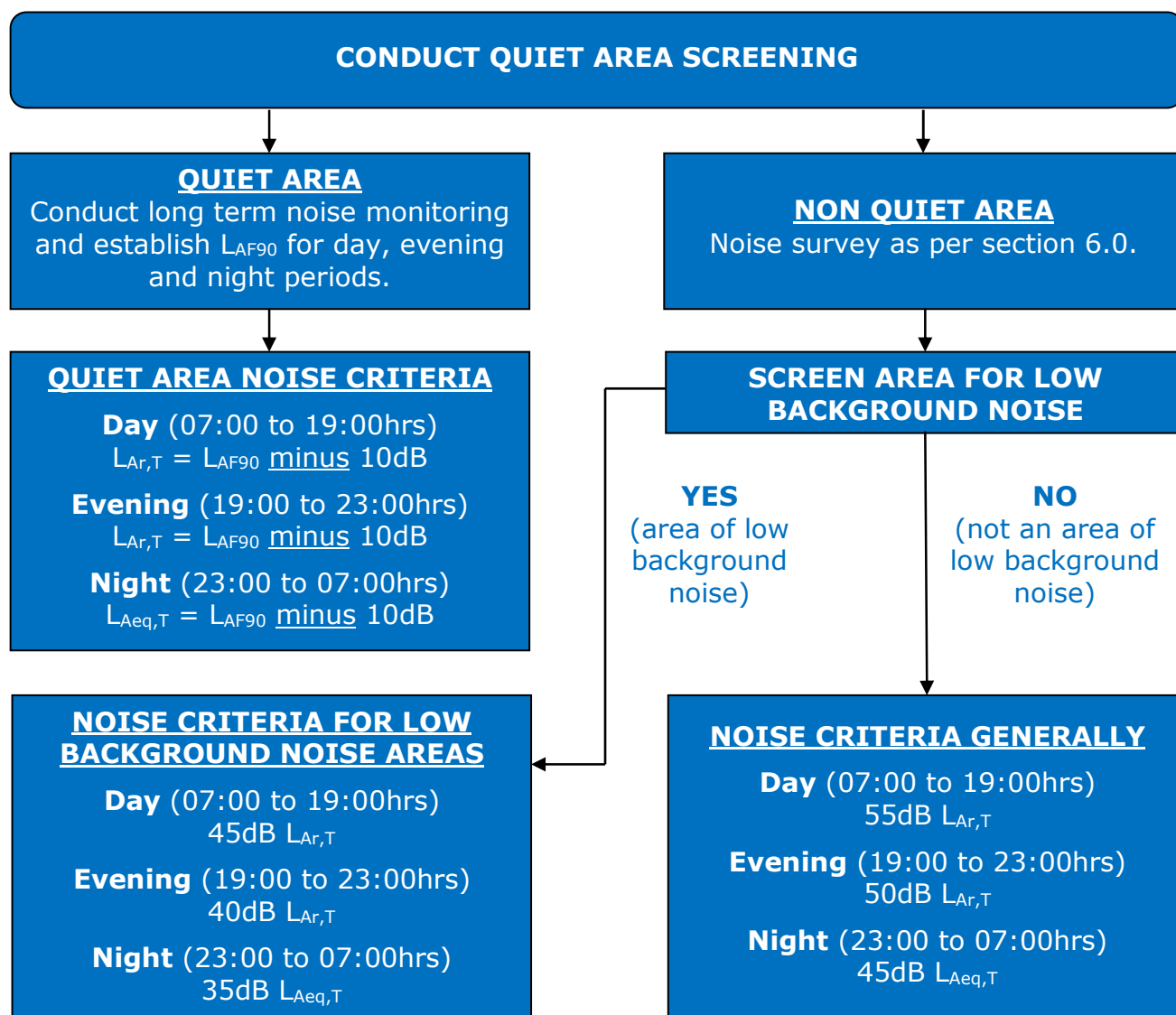
Table 1 outlines the noise limit criteria to be applied depending on the results of the screening processes discussed in Steps 1 and 3, and the noise survey discussed in Step 2.

**Table 1 Recommended Noise Limit Criteria**

Scenario	Daytime Noise Criterion, dB L <sub>Ar,T</sub> (07:00 to 19:00hrs)	Evening Noise Criterion, dB L <sub>Ar,T</sub> (19:00 to 23:00hrs)	Night-time Noise Criterion, dB L <sub>Aeq,T</sub> (23:00 to 07:00hrs)
Quiet Area	Noise from the licensed site to be at least 10dB below the average daytime background noise level measured during the baseline noise survey.	Noise from the licensed site to be at least 10dB below the average evening background noise level measured during the baseline noise survey.	Noise from the licensed site to be at least 10dB below the average night-time background noise level measured during the baseline noise survey.
Areas of Low Background Noise	45dB	40dB	35dB
All other Areas	55dB	50dB	45dB

Figure 3 overleaf illustrates the process by way of a flow chart. Examples of the derivation of appropriate noise criteria are presented in Appendix V of this document; this appendix provides worked examples for the various potential situations discussed in the previous paragraphs.



**Figure 3 Flow Chart for the Identification of Appropriate Noise Criteria**

## 4.5 Assessing Compliance with Criteria and Limits

An annual noise assessment is normally required at licensed facilities. The nature and scope of the assessment should be determined by the site-specific conditions and operational history. At a minimum the survey should comprise daytime, evening and night-time surveys of sufficient length to satisfy the minimum survey duration for various periods (as outlined in Section 7.2) at each monitoring location identified in the relevant licence.

With regard to licences predating this guidance note, it is necessary to conduct daytime and night-time surveys of sufficient duration to comply with the requirements set out in Table 5 (see Section 7.2). Note that this requirement is mandatory and is now applicable for all annual noise surveys at licensed sites with immediate effect, irrespective of the number of measurement locations. Further details on this issue are presented in Section 6.0 of this document.

The Agency would expect a licensee to undertake a more extensive assessment in situations where there has been a history of noise complaints. Outline guidance on complaint investigation is presented in Section 9.0 and Appendix X of this document.

## 5. ASSESSMENT OF TONAL & IMPULSIVE NOISE

It is widely accepted that noise with tonal or impulsive characteristics is likely to be more annoying than noise without such characteristics. The following guidance is presented in order to outline assessment approaches that will assist in the identification of tonal and impulsive noise emissions from a site at nearby NSL's. It is acknowledged that in certain instances (e.g. a tonal noise is subjectively noted but not identified using the advised approach) an alternative approach may be warranted; in these cases the advice of a competent person should be sought.

### 5.1 Identification and Rating of Tonal Noise Emissions

Some noise sources and industrial activities are inherently likely to give rise to tonal noise. Some examples of sources that may commonly generate tonal noise emissions are fans, compressors, motors and transformers. In addition, mains electricity can also be a common source of tonal noise. In this instance the tone is often noticed at the fundamental frequency of the electricity supply, i.e. 50Hz, and its harmonics.

In order to take into account the fact that tonal noise is more noticeable than **broadband** noise, and can therefore be more intrusive, it is appropriate to penalise tonal noise in assessments by applying a correction factor to the measured noise level in order to arrive at a 'rating level'.

The rating level ( $L_{Ar,T}$ ) is calculated by adding a penalty to the measured equivalent continuous A-weighted sound pressure level ( $L_{Aeq,T}$ ). The purpose of the rating level is to arrive at a better estimate of the potential community response to the measured noise.

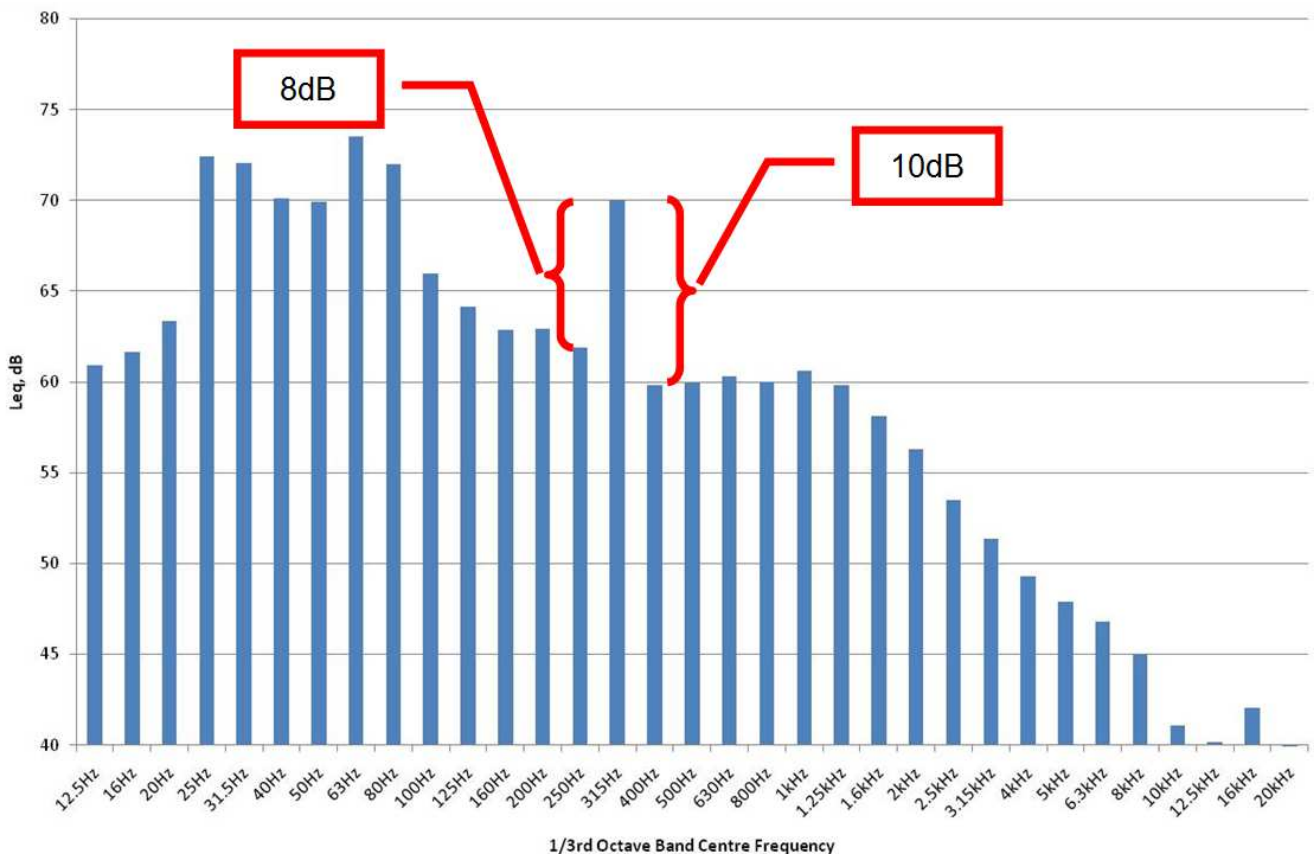
A tonal noise source can normally be subjectively identified by a competent person familiar with noise impact assessments. However, prior to the application of a rating penalty the Agency would recommend adoption of the simplified methodology for the objective identification of tones that is advocated in BS 4142: 2014: Annex C (normative): *Objective method for assessing the audibility of tones in sound: One-third octave method*. This methodology requires that for a prominent, discrete tone to be identified as present, the time-averaged linear sound pressure level in the one-third-octave band of interest is required to exceed the time-averaged linear sound pressure levels of both adjacent one-third octave bands by some constant level difference.

The appropriate level differences vary with frequency. They should be greater than or equal to the following values in both adjacent one-third-octave bands:

- 15dB in low-frequency one-third-octave bands (25Hz to 125Hz);
- 8dB in middle-frequency bands (160Hz to 400Hz), and;
- 5dB in high-frequency bands (500Hz to 10,000Hz).

Care should be taken to ensure that any tones identified in the low frequency range of 25Hz to 125Hz are of a magnitude greater than the threshold of hearing at that frequency, see Appendix VI. A template for the assessment of a tonal noise source is provided in Appendix VII along with further examples.

In order to illustrate this methodology Figure 4 gives an example where a tone has been objectively identified at 315Hz. Its presence is confirmed due to the fact that the level difference between the tonal frequency and the level in each of the adjacent one-third octave bands is greater than or equal to 8dB.

**Figure 4 Example of Tonal Noise Identification**

Note that the approach described here will suffice for the majority of situations where tonal noise is suspected to be present. In the event, however, that there is a difficulty in identifying a tonal noise source using this method, or there is disagreement over the presence of tonal noise, then the recommended approach is to adopt the methodology outlined in BS 4142: 2014: Annex D (normative): *Objective method for assessing the audibility of tones in sound: Reference method*.

The following examples illustrate when it may be appropriate to apply the more detailed reference method as opposed to the one-third octave method:

- In the event that an interested party believes that a tone is clearly audible even though the one-third method suggests that a tone is not present;
- If measurements conducted under different conditions and/or at different times return contradictory findings, i.e. application of the one-third method suggests the presence of a tone for one or more measurements whilst also suggesting the absence of a tone for another measurement (or measurements), and;
- If the level differences are within  $\pm 2$ dB of the values stated above and there is a dispute over the presence or otherwise of a tone.

Application of the reference method is a complex procedure, hence it should only be undertaken by a suitably competent person.

Where tonal noise is objectively identified a rating level based on the penalty as outlined in Table 2 is to be applied to the measured  $L_{Aeq}$ .

**Table 2 Recommended Tonal Noise Penalty**

Period	Sound Characteristic	Correction to $L_{Aeq}$ to Arrive at Rating Level $L_{A,r,T}$ (dB)
Daytime & Evening	Tonal	5
Night-time	Tonal noise from the facility should not be audible at any NSL	

If more than one adjustment is potentially applicable for the type or character of a given single sound source (i.e. a source that is both tonal and impulsive), only a single adjustment shall be applied.

All licensed facilities should use BAT to attempt to eliminate and control tonal components when identified, although it is acknowledged that it may be impractical to always completely eliminate some of these characteristics. At night-time, however, there should be no audible tonal noise at any NSL.

## 5.2 Identification and Rating of Impulsive Noise Emissions

Some noise sources and industrial sites also have the potential to generate impulsive noise. Whilst it is important to ensure that impulsive noise does not cause disturbance or annoyance, it is sometimes not practical to completely eliminate this type of noise.

An impulsive noise may sometimes exist at such a low level that it would be acceptable to sensitive receptors, and would be unlikely to cause any disturbance or annoyance. To require a complete absence of impulsive noise in such cases may be impracticable and of little benefit.

Normally an impulsive characteristic is determined subjectively as it is clearly audible. Currently, no mathematical descriptor exists which can define unequivocally the presence of impulsive sound. Appendix VIII provides additional advice in relation to the definition of various types of impulsive sounds that may be encountered.

A noise source that attracts an impulsive characteristic will often be described as something with a thumping, banging or impact noise that is clearly audible above everything else. It is distinguished by a sharp rise in noise level. Some examples include the noise from a heavy mechanical press that consistently produces an impact noise as it stamps out a metal template, the noise from the dropping of material that causes a short burst of loud sound as the material hits the ground or the noise of heavy hammering and banging from a workshop area.

An impulsive characteristic would not be applied to a noise that simply varies in level. A short burst or impact, or series of impacts, need to be present in order to apply the impulsive characteristic.

An impulsive characteristic can be identified objectively in accordance with the method in ISO 1996-2:2007(E). The method involves measuring the noise using an impulse **time weighting 'I'** and comparing this against the result for a fast time weighting 'F'. A difference of 2dB or greater is considered to indicate the presence of an impulsive characteristic.

Care should be exercised when applying this approach, for a number of reasons as follows:

- The influence that ambient noise sources can have on the result. For example, passing traffic may be sufficient to cause a 2dB or greater difference between the different time weighted results. To assist in ensuring ambient noise does not influence the result, a sound level meter that allows for concurrent measurement of fast and impulse time weighting should be used and care should be taken during the measurement period to isolate the noise source, and;
- It is possible to exceed the 2dB difference for noise sources that are subjectively considered to exhibit a modulating characteristic rather than an impulsive characteristic. An example is that of intermittent passing traffic which can exhibit a difference of 2dB over a 15-minute period.

The test should therefore generally be used to show the impulsive characteristic is not present. This is done by recording a test where the difference is less than 2dB. Care should be exercised with a test to definitively show the presence of an impulsive characteristic, particularly where the difference is close to 2dB.

In the event that there is any uncertainty over the presence or otherwise of impulsivity in a given noise, reference may be made to the approach set out in BS4142: 2014: Annex (normative): *Objective method for measuring the prominence of impulsive sounds and for adjustment of  $L_{Aeq}$* . The following examples illustrate when it may be appropriate to apply this more detailed method:

- In the event that site conditions mean that application of the simpler ISO1996-2:2007(E) method is not practicable (e.g. due to the influence of extraneous noise sources);
- If measurements conducted under different conditions and/or at different times return contradictory findings, i.e. application of the simpler method suggests the presence of impulsivity for one or more measurements whilst also suggesting the absence of impulsivity for another measurement (or measurements), and;
- If interested parties dispute the presence or otherwise of impulsivity, irrespective of the findings arising out of application of the simplified method.

Application of the BS 4142: 2014 method is a complex procedure, hence it should only be undertaken by a suitably competent person.

Where impulsive noise is identified a rating level based on the penalty as outlined in Table 3 is to be applied to the measured  $L_{Aeq,T}$ . If a 'highly impulsive' or 'high energy impulsive' source is suspected, advice is to be sought from a suitably competent person and the associated impacts must be assessed on a case by case basis, as a 5dB correction may not be considered sufficient in certain instances.

**Table 3 Recommended Impulsive Noise Ratings**

Period	Sound Characteristic	Correction to $L_{Aeq}$ to Arrive at Rating Level $L_{Ar,T}$ (dB)
Daytime & Evening	Impulsive	5
Night-time	Impulsive noise from the facility should not be audible at any NSL	

If more than one adjustment is potentially applicable for the type or character of a given single sound source (i.e. a source that is both tonal and impulsive), only a single adjustment shall be applied.

While all licensed facilities should use BAT to eliminate and control impulsive components, it may be impractical to always completely eliminate some of these characteristics. At night-time, however, there should be no audible impulsive characteristic to the noise at any NSL.

## 6. NOISE INPUTS INTO IPPC/WASTE LICENCE APPLICATIONS

An important aspect of the licensing process relates to the provision of the initial noise impact assessment of the proposed activity on the existing environment. The approach to the noise measurements that must be completed in support of a licence application has been outlined previously in Section 4.0 of this guidance note.

The following sections provide further guidance in relation to the level of information and assessment required in order to allow the Agency to complete a robust and in-depth review of any potential noise impact associated with a facility.

As part of the IPPC/Waste Licence application the applicant must provide information relating to:

- Noise emissions from the facility;
- An appropriately detailed assessment of the impact of those emissions on NSL's, and;
- The noise control measures that will be implemented/installed (where necessary).

Each application will obviously vary with more detailed and in-depth acoustic assessments required for certain (typically larger) facilities. This is to say that the higher the potential for a site to cause annoyance or other environmental impact, the more detail that is required, including detailed and specific recommendations on proposed noise control measures.

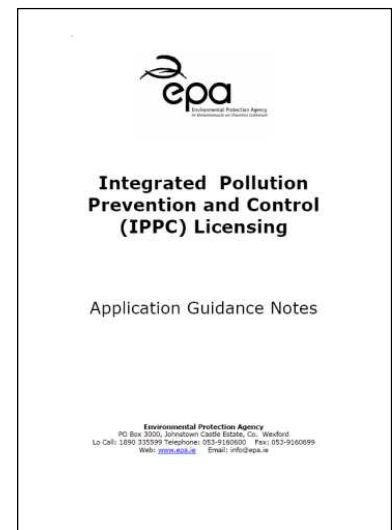
### 6.1 Stage 1 – Baseline Noise Survey/Monitoring Locations

Section 4.0 of this document outlines the extent and nature of the noise survey that should be undertaken as part of a licence application. Appendices III, IV and V illustrate how the noise data from these surveys should be reviewed and presented to the Agency. The following paragraphs present some guidance on how noise measurement locations should be identified.

The measurement positions should include those positions which will be most affected by the facility's emissions. The following process is recommended:

- An initial site inspection should be carried out with a view to identifying all NSL's in the vicinity of the proposed development;
- NSL's should be marked onto relevant drawings and the proposed development overlaid, and;
- At this stage some preliminary noise calculations should be undertaken with a view to identifying locations where noise monitoring should be focused (e.g. if site orientation indicates that noise emissions will be higher to the south of a site additional noise monitoring locations may be chosen at NSL's in this vicinity).

Given that the locations selected at this stage will influence the noise measurement locations that will be defined in any licence issued to an operator, appropriate positions should be selected with reference to the definition of 'NSL'. The choice of measurement location is often not straightforward. Generally the main issue to be addressed is quantifying the noise level experienced by the affected people. This usually implies measurement outside the 'most exposed' window of the building they occupy.





This is not always practical, however, and measurements must sometimes be taken elsewhere. In these cases consideration should be given to the following guidance contained within BS 4142: 2014: *Methods for rating and assessing industrial and commercial sound*:

'Choose measurement positions that are outside buildings that will give results that are representative of the levels at the buildings where people are likely to be affected.'

Ongoing access will typically be required to the noise measurement locations selected in these instances. Therefore issues of ongoing access arrangements (e.g. if the measurement location is on private property) should be given appropriate consideration in the selection of noise measurement locations.

The noise criteria outlined in this document are '**free-field**' levels, i.e. levels where the influence of reflections has been minimised. Whenever possible, the noise measurements should therefore be carried out at least 3.5 metres from any reflecting structure other than the ground. The preferred height for the microphone is 1.2 to 1.5 metres above ground level.

In certain instances it may be more appropriate to identify boundary locations in relation to ongoing or permanent monitoring locations (e.g. in terms of the Annual Noise Survey). Where boundary locations are being proposed careful consideration should be given to the following issues:

- The boundary location may be in an '**acoustic shadow**', for example, if the principal source is a set of extract fans on the roof of the facility, a location on the boundary may benefit from acoustic screening provided by the site buildings themselves. The resultant measured levels would not be representative of noise emissions from the site;
- It may be difficult to achieve a free-field measurement location (that is, away from building reflections), in which case any necessary corrections as a result of such reflections should be applied, and;
- In the case of large installations, a boundary measurement location may not be representative of the sound levels at the receptor.

If a boundary location is adopted as an ongoing position for annual noise measurement careful consideration should be given to the noise levels obtained. If NSL's are close to the boundary the situation is straightforward and the measured levels can be easily interpreted to demonstrate compliance with relevant noise criteria. However, if the nearest NSL's are somewhat removed from the boundary measurement location the expected noise levels should be extrapolated to the nearest NSL's. The extrapolation will not be as accurate as measurement and, therefore, it is preferable to enforce noise criteria by measurement at NSL's.

It may be appropriate to define measurement locations that are neither in the immediate vicinity of the nearest NSL nor on the site boundary, in order to provide results that are more straightforward to interpret and/or extrapolate.

## 6.2 Stage 2 – Derivation of Noise Criteria

Based on the results of the baseline noise survey the relevant noise criteria for the site should be derived as per the guidance contained in Section 4.4 of this document.



### 6.3 Stage 3 – Assessment of Noise Impact

The noise levels expected at site boundaries and NSL's will need to be considered and presented as part of a licence application. ISO 9613-2:1996 offers detailed guidance on calculating the propagation of noise outdoors. It shows how to incorporate the effect of many factors including barriers, ground absorption and air attenuation. ISO 9613-2 is also the basis for many computer-based noise modelling packages and, as a matter of default, is the calculation methodology preferred by the Agency in terms of scheduled activities.

Other calculation methods may be used in certain instances (e.g. CONCAWE<sup>22</sup>) but the use of such methods should be fully justified.

Table 4 outlines a check list for the preparation of detailed noise calculations and associated noise assessment in relation to licensed activities.

**Table 4 Noise Prediction and Assessment Checklist**

Item	Considered?
	Yes (✓)
Have a suitable site noise survey and inspection been completed?	<input type="checkbox"/>
Have the correct NSL's been chosen?	<input type="checkbox"/>
Have the correct details been assigned to the NSL's (e.g. height, exposed façade(s), local screening, line of sight to critical noise sources etc.)?	<input type="checkbox"/>
Have the correct survey periods been chosen to account for time varying, infrequent and ancillary activities?	<input type="checkbox"/>
Select the appropriate level of detail for noise prediction (e.g. simple spread sheet calculation of overall noise levels for simple site, to detailed octave band calculations for more complex situations).	<input type="checkbox"/>
Have suitable noise criteria for day, evening and night time periods been derived from the survey data?	<input type="checkbox"/>
Have all significant external noise sources been identified and associated noise data obtained (either through measurement, empirical equations or manufacturers' data)?	<input type="checkbox"/>
Has noise breakout from buildings been considered in appropriate detail (e.g. noise across open doors, louvres, ventilation systems etc.)?	<input type="checkbox"/>
Have the proper considerations for noise source type (i.e. line, point, plane), 'on time' and directivity corrections etc. been applied to the relevant noise sources?	<input type="checkbox"/>
Appropriate consideration of: - ground topography between sources and receivers; - site buildings and intervening structures (e.g. barriers); - reflections; - ground absorption; - temperature and humidity?	<input type="checkbox"/>
Do the final results appear conclusive?	<input type="checkbox"/>



## 6.4 Stage 4 – Reporting/Licence Application Form

The noise survey, derivation of appropriate noise criteria, noise calculations (including full details of input data, methodologies and any pertinent assumptions) should be collated in a detailed technical report that is to accompany a licence application. This document should also clearly outline the process undertaken to identify appropriate noise criteria for the site as detailed in Section 4.0 of this document.

The site should be described in relation to its noise output. The main sources of noise on site should be identified and supplied in Table E.5(i) of the application form (reproduced in Figure 5 for clarity) e.g. an activity, process or specific item of equipment likely to generate noise outside the site boundary.

For all major sources of noise the following details are required:

- Precise location (12 digit, 6E, 6N);
- Sound Power level ( $L_{WA}$ ) or Sound Pressure level ( $L_{pA}$ ) at an appropriate reference distance, measured over a sufficient time period to ensure that all significant temporal and level variations are encompassed;
- Activity Sound level ( $L_{eq,T}$ ) at a reference distance;
- Power rating of equipment if applicable;
- Duration and occurrence, day/night level, continuous or intermittent;
- Character i.e. broadband, tonal or impulsive;
- Frequency profile, and;
- Details of any attenuation, noise control measures.

For all NSL's, noise calculations should be presented (in terms of  $L_{Aeq,T}$ ) and compared against the relevant noise criteria. Where calculated noise levels are in excess of the relevant noise criteria, derived as part of the overall acoustic assessment prepared for the licence application, appropriately detailed remedial measures should be identified and the expected noise attenuations offered clearly stated and technically justified.

Figure 5 Licence Application Table E.5(i)<sup>vii</sup>

Table E.5(i): NOISE EMISSIONS - Noise sources summary sheet

Source	Emission point Ref. No	Equipment Ref. No	Sound Pressure <sup>1</sup> dBA at reference distance	Octave bands (Hz) Sound Pressure <sup>1</sup> Levels dB(unweighted) per band								Impulsive or tonal qualities	Periods of Emission
				31.5	63	125	250	500	1K	2K	4K	8K	

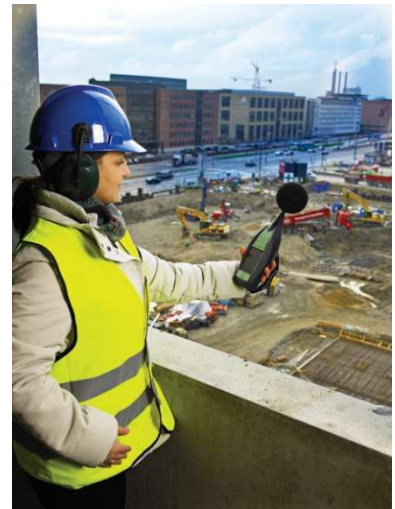
1. For items of plant sound power levels may be used.

<sup>vii</sup> Periods of Emission should state if the plant item in question operates on a continuous or intermittent basis. If intermittent then further details of the hours of operation and any potential impulsive components associated with the source should be clearly identified.

## 7. ENVIRONMENTAL NOISE SURVEYS

Many sites within the IPPC and Waste Licensing regime are subject to an Annual Noise Survey. While every licensed facility needs to be considered on a case by case basis, this section outlines some further general guidance in relation to the implementation of a noise survey and assessment methodologies which will typically fulfil the Agency's requirements.

It is important to note that this guidance note cannot be considered in isolation, and it must be interpreted in relation to the site-specific conditions pertaining to each site. Reference must also be made to relevant acoustical standards (principally ISO and British Standards). While the following sections in no way attempt to interpret the relevant provisions of these standards for every particular case, they do provide an overview of the methodology and assessment approach that is required for the majority of Annual Noise Surveys.



### 7.1 The Scope of the Annual Noise Survey

In planning to undertake an Annual Noise Survey a number of factors need to be considered. These include:

- The precise wording of the IPPC or Waste Licence conditions in relation to noise;
- Whether noise limits have been stipulated for boundary and/or NSL positions;
- Whether noise limits have been stipulated for specific items of equipment/plant;
- Whether measurements are required at stipulated intervals, e.g. on a biannual or quarterly basis;
- Local environmental and acoustic conditions (e.g. localised or extraneous noise sources), and;
- Relevant changes at the facility (e.g. plant or operational changes) since the last noise survey.

While the above list is by no means exhaustive, it does itemise some of the primary considerations.

In practice the scope and the extent of the Annual Noise Survey will need to reflect the site-specific conditions and the operating history of the site. While specific guidance on complaint investigation is beyond the scope of this document, the Agency will normally expect a licensee to undertake a more extensive Annual Noise Survey in situations where there has been a history of noise complaints. Other factors which will influence the scope and duration of the Annual Noise Survey include:

- The location, proximity and sensitivity of NSL's (NSLs) and other receptors;
- The likelihood of noise emissions causing annoyance and/or disturbance;
- The nature and character of the locality and the background noise (i.e. ambient noise in the absence of noise from the specific facility);
- The presence or absence of topographical features and/or buildings or other such structures which may help to attenuate the noise emissions;
- The characteristics of the noise sources at the facility, e.g. is the noise typically broadband, tonal and/or impulsive;
- The occurrence of regular scheduled (although possibly infrequent) activities that may have a significant bearing on noise emission levels, and;

- The normal operating times of noise sources at the facility and any possible variations or irregular emissions. Intermittent emissions, even those of short duration, can cause annoyance and/or disturbance.

With particular reference to the latter point, it is important to note that noise emissions are more likely to cause disturbance and/or annoyance during periods when the background noise is relatively low. In this regard, noise complaints are more likely during time periods when receptors are less tolerant of noise (e.g. night-time, weekends, and bank holidays).

In instances where a facility does not normally operate during night-time, certain noise sources may continue to function continuously (e.g. refrigeration plant and/or compressors). In most situations the survey work will need to be undertaken during daytime, evening and night-time. Only in situations where no noise sources whatsoever operate during night-time will a daytime and evening survey suffice. Likewise, in situations where no noise sources whatsoever operate during evening and night-time, it will be sufficient to conduct a daytime survey only. In any event the timing of the survey work is a critical factor. It is important that the survey is undertaken during a period which is representative of typical or preferably worst-case operational conditions, i.e. when the site is operating at nominal maximum capacity.

It is recognised that practical constraints may preclude the survey from being undertaken during 'worst-case' conditions. However, all potentially significant noise sources at the facility should be operational at the time of the survey. If this is not possible, the survey report should draw attention to this fact and it should provide some justification for undertaking the survey work in the absence of a particular significant source. Where practicable, a predictive technique should be used to estimate the potential impact when the particular source is operational.

When an intermittent source does not cause any significant impact at any NSL or boundary position, it is permissible to proceed with the survey work during a period when such a source was not operational. However, the fact that the survey was undertaken under such conditions should be noted in the survey report.

Note that the Agency reserves the right to specify alternative and/or extended survey periods in order to ensure that measured levels are wholly representative of site noise emissions.

## 7.2 Survey Methodologies and Assessment Procedures

Monitoring for compliance with the noise emission conditions of an IPPC or Waste Licence should be primarily based upon International Standard ISO 1996: *Acoustics – Description, Measurement and Assessment of Environmental Noise*.

Ideally, sampling over different days and at different times during the day will help to ensure that the survey is statistically representative. However, there are many practical constraints militating against this. Where noise emissions are relatively steady, a series of measurements should be undertaken as set out in Table 5.

**Table 5 Recommended Minimum Survey Durations**

Period	Minimum Survey Duration
Daytime (07:00 to 19:00hrs)	A minimum of 3 sampling periods <sup>viii</sup> at each noise monitoring location.
Evening (19:00 to 23:00hrs)	A minimum of 1 sampling period at each noise monitoring location.
Night-time <sup>ix</sup> (23:00 to 07:00hrs)	A minimum of 2 sampling periods at each noise monitoring location.

Guidance on the interpretation of Table 5 is provided below.

**Daytime:** If an existing licensed site has just one NSL, then a minimum of 3 no. consecutive 30 minute measurements (i.e.  $3 \times 30 = 90$  minutes) will be required. For two NSL's, that will increase to  $3 \times 30 \times 2 = 180$  minutes etc.

**Evening:** If an existing licensed site has just one NSL, then a minimum of 1 no. 30 minute measurement (i.e.  $1 \times 30 = 90$  minutes) will be required. For two NSL's, that will increase to  $1 \times 30 \times 2 = 60$  minutes etc.

**Night-time:** If an existing licensed site has just one NSL, then a minimum of 2 no. consecutive 30 minute measurements (i.e.  $2 \times 30 = 60$  minutes) will be required. For two NSL's, that will increase to  $2 \times 30 \times 2 = 120$  minutes etc.

The daytime and night-time survey durations apply to all existing IPPC & waste licensed sites. The evening survey times only apply to new or revised licences as per the licence conditions, i.e. evening survey times do not routinely apply to existing licences.

Monitoring conducted for the specific purposes of assessing the presence or otherwise of tonality and/or impulsivity does not count towards the minimum number of sampling periods per Table 5.

The minimum sampling requirements specified in Table 5 will ensure that the noise results generated in respect of the licensed site are representative and reproducible.

It is important that the survey is undertaken during a period which is representative of typical or worst-case operational conditions, including the effects of weather. If this is not sensible or practicable on account of weather conditions, process cycles, extraneous noise interference or any other reason, then this should be stated in the reporting associated with the survey work.

Measurement positions are to be those stipulated in the relevant IPPC or Waste Licences. In instances where a new noise sensitive receptor is built in closer proximity to the facility in question, that was not present at the time of the licencing process, the annual noise survey should be amended and additional monitoring should be carried out at any such location on an ongoing basis. Likewise, survey locations should be amended in the event that a formerly noise sensitive receptor no longer constitutes an NSL, e.g. a house that is demolished or subject to a change of use.

The selection of measurement positions is further addressed in Section 7.3. In practice, suitable positions will generally include points along the site boundary or positions at specified NSL's as per the relevant licence. Intervening ground conditions, buildings, distance and other factors affect noise propagation from a facility. Significant variations from the prevailing conditions applicable during preceding surveys should be noted.

<sup>viii</sup> Sampling period is to be the time period T stated within the relevant licence. Typically this will be either 15 minutes or 30 minutes in duration. This applies to day, evening and night time periods.

<sup>ix</sup> Night-time measurements should normally be made between 23:00hrs and 04:00hrs, Sunday to Thursday, with 23:00hrs being the preferred start time.

It should be remembered that one of the objectives of the survey is to compare the measured noise levels at the current time with those at a previous time. All other factors should be as close as possible to being the same, at least over the representative sampling interval or period.

Measurements should be attended in most cases in order that the numerical values obtained can be confirmed by the assessment personnel as being wholly attributable to the activity under investigation. Attended measurements will facilitate the identification of extraneous sources and tonal elements. In certain cases, automatic unattended logging of noise levels may be appropriate, e.g. boundary noise measured very close to a facility where there is no doubt as to the source of the noise. In the latter case, concurrent measurement of the weather conditions at the measurement location will be required.

All noise monitoring results and any derived averages should be rounded to the nearest whole integer, with 0.5 being rounded up.

If it can be demonstrated, on the basis of historical noise data and complaint history (or lack thereof), that a site is in compliance with its noise limit values and it does not give rise to noise nuisance, the Agency may agree to relax the survey requirements. Any such relaxation must be sought prior to survey work commencing and can only be given with the written agreement of the site inspector.

### 7.3 Measurement Positions

In the first instance regard must be had to the relevant conditions in the IPPC/Waste licence. Generally limits will be specified for NSL's. In some instances noise measurements will be required at boundary positions or for specified pieces of equipment or plant. In the latter case, generally, a specified measurement position is given in a schedule to the issued IPPC/Waste Licence.

Measurement positions should be as close as possible to the position specified in the relevant licence conditions. If for any reason these positions are not accessible and/or are unsuitable, then alternative positions may have to be selected in consultation with the Agency.

Given that the primary objective of the Annual Noise Survey is to determine the level of compliance, the measurement positions should include those positions which are most affected by the site's emissions.

The noise limits which are imposed by IPPC/Waste licence conditions are 'free-field' levels, i.e. levels where the influence of reflections has been minimised. Whenever possible, therefore, the noise measurement should be carried out at least 3.5 metres from any reflecting structure other than the ground. The preferred position for the microphone is 1.2 to 1.5 metres above ground level.

If there is local screening that could lead to a reduction in levels at 1.2 to 1.5 metres above the ground, and there are sensitive receptors in the vicinity with accommodation at first floor level and above, the microphone height should be increased to *ca.* 4m. This is particularly important if there are night-time operations that could affect bedrooms.

In situations where measurements are being taken at an NSL, generally the boundary of the NSL (e.g. just outside the garden of a domestic house) can be the most useful measurement position. This helps to avoid the influence of domestic noise and also eliminates the need for trespass onto private property etc.

In certain instances, however, measurements at the boundary of an NSL may be supplemented by measurements close to the building of interest (i.e. **façade levels**). In the case of the latter, the appropriate measurement position would be 1 to 2 metres from the façade and 1.2 to 1.5 metres above each floor level of interest. If this approach is taken the appropriate façade correction should be made when reporting the results obtained for direct comparison against the relevant noise criterion. Where it is proposed to undertake noise measurements late at night, then the notification of the local land owner(s) and neighbour(s) should be considered.

Where necessary, precautions should be taken in order to minimize the influence of electrical and electromagnetic interference, which can be caused in the sound measuring system by, for example, nearby power cables or radio transmitters.

## 7.4 Measurement Equipment

It is essential to ensure that the equipment used for monitoring can be guaranteed to perform within set tolerances.

### Sound Level Meters

Various companies offer a number of different kinds of noise measurement equipment with several levels of complexity. The options include instrumentation that only measures basic time varying sound pressure level, at the lower end of the range, to those which have the functionality to perform statistical and frequency analysis.



Sound level meters, microphones and calibrators have to comply with a range of national and international standards and in Ireland Type 1 (or Class 1), referring to the relevant British or ISO standard, should be used for environmental noise measurement by all parties involved in the assessment of noise. If calibrated recordings are obtained for the purposes of off-site analysis, it is the responsibility of the competent person conducting the assessment to demonstrate that the entire measurement and analysis chain complies with the Type 1 requirements.

Sound level meters used for the purposes of IPPC/Waste licensing measurement and assessment should be capable of measuring and storing the A-weighted equivalent sound level ( $L_{Aeq,T}$ ), statistical indicators (e.g.  $L_{AF90,T}$ ,  $L_{AF10,T}$ ), maxima/minima (i.e.  $L_{AFmin,T}$ ,  $L_{AFmax,T}$ ) and 1/3-octave band data (to allow for appropriate assessment of tonal noise).

The principal noise index to be recorded will generally be the  $L_{Aeq,T}$ , the continuous A-weighted sound level containing the same amount of acoustical energy as the measured varying noise over the measurement period, T. This time period must be specified for the measurement result to be meaningful.

Most modern instrumentation will provide two different exponential time weightings – ‘fast’ (with a nominal exponential time constant of 125 milliseconds) and ‘slow’ (nominal exponential time constant of 1 second). Fast is generally the preferred time-weighting, especially for statistical data and for variable noise levels.

It is also useful to know the frequency content of a noise source when calculating noise attenuation from screens, enclosures etc. and when considering ground absorption in calculations, as all these effects are frequency dependent.



Modern sound level meters usually have a wide dynamic range of around 80dB or more and can measure peak levels of over 140dB. The measurement scales go down as low as 20dB and below. However, meters and microphones constituting measurement chains will produce electrical noise which can influence readings. It is recommended that any noise level measured below 25dB should be viewed with caution and manufacturers should be consulted in relation to the noise floors associated with their instrumentation. Care should be taken in selecting the most appropriate dynamic range setting in order to exclude overloaded and under-ranged measurements. Overloads in particular could give rise to significant errors in measurement results.

Microphones should always be mounted and oriented in accordance with the manufacturer's instructions, with due regard to directivity characteristics.

If long-term measurements are being carried out, care should be taken to protect the instrument and microphone, ideally using the manufacturer's recommended approach in order to maintain measurement integrity.

### Calibration of Sound Level Meters

#### Field Calibration

Each sound level meter system should consist of the meter itself, along with a calibrator and dedicated microphone. A typical field calibrator produces a tone of 94dB SPL at 1kHz.

As a matter of good practice, and in line with relevant standards, sound level meters should be calibrated in the field with appropriate acoustic calibrators before each series of measurements and check calibrated on completion.

If long-term measurements are being undertaken, the meter must be calibrated at regular intervals (e.g. once every two weeks). Calibration levels are to be recorded (often the instrumentation itself logs calibration events). Some long-term noise monitoring systems are capable of performing automated, periodic calibration routines. The validity of such routines should be clarified with the manufacturer and, subject to this being satisfactory, may be used to supplement regular acoustic calibrations.

In instances where there is a significant variation in calibration levels before or after a measurement period, the results may have to be disregarded or treated with caution.

#### Laboratory Calibration

An accredited laboratory must calibrate sound level meters and calibrators on a periodic basis. BS 7580:1997 *Specification for the verification of sound level meters*<sup>23</sup> recommends, and it is the opinion of the Agency, that sound level meters should be verified at least every two years. Calibrators must be calibrated at least once a year.



## 7.5 Noise Indices

The fundamental requirements for the Annual Noise Survey are to determine whether or not the licensed activity complies with the noise limit values as set out in its licence and to ensure that there is no evidence of tonal or impulsive characteristics at night-time.

While, in most situations, a subjective assessment of the presence of tones and impulsive elements can be made, appropriate procedures for objective assessment are presented in Section 5.0 of this document.

In many instances the A-Weighted sound pressure level serves as an adequate descriptor and while  $L_{Aeq,T}$  and  $L_{Ar,T}$  are the most commonly used indices, percentile levels should always be reported. This will help to further describe the characteristics of the measured noise.

While modern instrumentation will permit the logging and recording of a substantial number of indices, the following standardised parameters are considered to be important:  $L_{AF10,T}$ , and  $L_{AF90,T}$ .

Where the noise emissions are characterised by a number of discrete events, the additional use of  $L_{AFmax}$  and A-weighted **Sound Exposure Level** (SEL, sometimes expressed  $L_{AX}$  or  $L_{AE}$ ) is recommended.

Alternative indices may be used to supplement the foregoing, and these should all be detailed in a Noise Measurement Report. Guidance on the data to be contained in such reports is given in the form of templates which are presented in Appendices III and IV.

## 7.6 Weather Conditions

Ideally, measurements should be taken in 'neutral' weather conditions. This means in the absence of precipitation, and in conditions of standard temperature and pressure; wind should either be absent or no more than around 1m/s. Clearly, these conditions very rarely apply. However, the potential errors in measurement results are small if reasonable care is taken to avoid the worst excesses of the elements.

The SLM must be fitted with a proprietary windshield (i.e. not a 'dust cover') under all circumstances. An average wind speed of less than 5m/s is the required limit during periods when noise measurements are being taken. Occasional exceedances of up to 7m/s due to gusting wind conditions may be acceptable. In all cases, care should be taken to avoid measurements so close to objects as to give rise to wind-derived noises, e.g. trees, pylons, etc. Note that, even when windshields are used, a degree of wind-generated noise attributable to the instrument itself can be expected under certain conditions; this must be taken into consideration when survey results are being analysed and presented.

Wind speed and wind direction have the potential to affect noise propagation and hence the noise measurements. The prevailing weather conditions at the time of measurement should be noted and recorded in the survey report. In certain instances a meteorological station may be located close to the measurement position (although not so close as to affect the measured noise level) and in such cases the available met data should be accessed and referred to in the noise measurement report. Portable anemometers should be used to supplement any such data, with measurements of wind speed being taken before, during and after noise survey periods. In terms of the extended noise measurements required in 'quiet areas' as outlined in Section 4.0 a rain gauge and anemometer will be required in conjunction with the sound level meter for the duration of the survey.

Measurements should generally be avoided in rainy or dense foggy conditions. Common sense must be used at all times to protect the instrumentation and the prevailing conditions must be clearly stated to allow a qualitative judgement to be made on the validity of the measurements.

In general, noise attributable to wind and or rain should be at least 10dB below the noise source being measured, otherwise the measurements may be unduly influenced.

Temperature and humidity can affect the air absorption, although in practice these effects are often much less than those of distance, barriers, wind and the like, and are unlikely to have a significant effect, especially at low frequencies. However, under some conditions, such as temperature inversions, sound propagation can become very complex and result in localised focussing of noise. If this is considered to be an issue at hand, specific advice should be sought from a competent person.

## 7.7 Ground Attenuation

If the intervening ground between a noise source and a measurement location is acoustically absorptive, this can result in a reduction in noise level at the receptor due to absorption of sound energy by the ground itself. This aspect particularly needs to be considered when propagation distances are above 300m.

Acoustically absorptive ground types include grassed areas, tillage fields and forests with ground covering vegetation. Examples of acoustically reflective ground would be areas of water and concrete.

The proportion of hard and soft ground between the source and the receptor point should be noted as a simple percentage (e.g. 50% grassland, 50% water). If the ground attenuation conditions are considered to vary appreciably with the seasons, the noise survey should ideally be carried out at a time when ground absorption is at a minimum, this corresponds to a time when public reaction to the facility is likely to be highest.

Ground attenuation has little effect on high level sources, when the receiver has a clear line of sight to the source. Ground effect may be greatly reduced or even eliminated where an acoustic barrier is in place.

## 7.8 Noise Attributable to a Particular Activity

The conditions of any IPPC/Waste Licence apply to one specific site, i.e. the licensed activity. However, it is possible that over time other industries or sources of noise will encroach on an area that was previously only affected by the licensed site. This produces some significant difficulties in measuring the noise that is attributable to the licensed site alone. However, there are several techniques that can be applied to assist in identifying noise attributable to a particular source. These techniques generally require a high level of competence in acoustic measurement.

For facilities that operate continuously for 24 hours, it may be appropriate to measure at a time when all (or most) other noises have subsided. This will often mean measuring late at night when general traffic noise has reduced. Where noise output from the facility can be temporarily eliminated or subdued, it may be possible to estimate the facility's **specific noise level** by measuring the noise level with and without the facility running. The use of pausing techniques and short-term sampling intervals may also help to ascertain the noise attributable to the source of interest.

If the specified measurement position is a significant distance from the noise source with few intervening barriers or buildings, it may be possible to measure closer to the source where there may be less extraneous noise and then calculate the 'attributable' noise contribution at the greater distance using standard techniques. However, it is not valid to take measurements very close to a particular source and then calculate these levels. The closest reliable position at which measurements may be taken is at a distance of at least two times the largest dimension of the noise source. For example: a distance of at least 10m from a compressor house with dimensions of 5m x 3m x 4m.

If it is not possible to measure at the optimum position, e.g. for safety reasons, this should be clearly stated and due account taken of the likely effect on the measured values.

In terms of noise calculation, advice should typically be sought from a competent person. Section 6.3 outlines noise calculation methods etc. that may be utilised in such instances.

Appropriate guidance in relation to the accurate determination of specific levels is provided in BS 4142: 2014 section 7.3 *Determination of the specific sound level*. This should be applied in the event that there is any difficulty in obtaining results that are wholly attributable to the activity under investigation.

## 7.9 Interpretation of the Results

The results of the Annual Noise Survey must be presented to the Agency and guidance on the contents of the report is presented in Appendices III, IV and V. All noise monitoring results and derived averages should be rounded to the nearest whole integer, with 0.5 being rounded up.

The interpretation of the measurement results will form a critical part of the report and it should include a general description of the measurements, including a summary of the levels of the various noise descriptors for the relevant time periods. Special note should be made of the character of the sound and the presence or otherwise of tones or impulsive elements. The report should highlight whether the rating level was adjusted to account for these tonal or impulsive elements. Subjective comments on audibility and the dominance of noise sources should also be included along with difficulties in identifying sources etc.

The report should clearly interpret the noise results and highlight whether noise from the activity or extraneous noise sources are the dominant contributors to the noise levels measured. This interpretation should be based on the various noise measurements and any comments included on the dominant and/or intermittent sources of noise at the various measurement locations.

It is acknowledged that, on some sites, extraneous noise sources unconnected with the activity under consideration may unduly influence the measurements. In such situations, every effort should be made to ascertain the site specific noise level by following the approach set out in Section 7.8. Where findings remain inconclusive in this regard, it may be appropriate to use the  $L_{AF90,T}$  indicator to give a good indication of the actual noise output from the site, provided noise emissions from the site are steady. For example, if a measurement location is situated near to a busy road, the  $L_{AF90,T}$  indicator might provide a more accurate representation of the magnitude of site noise emissions through the exclusion of contributions attributable to vehicle pass-bys. Note that, even if  $L_{AF90,T}$  is used to assist with the interpretation of noise emission data attributable to a given site or activity, the measured values for  $L_{Aeq,T}$  must also be presented in the report. The reasons for the use of  $L_{AF90,T}$  must also be presented in order to ensure that its use is justified.

The report should also outline any steps taken to reduce uncertainty in accordance with the guidance given in BS 4142: 2014 section 10 *Uncertainty*.

## 7.10 Information to be contained in Reports

Table 6 contains a checklist of the information that should be contained as a minimum within the annual noise report for a site; it should be reviewed and completed prior to the submission of the Annual Environmental Report (AER).

The conditions of the measurements should be carefully documented in a formal measurement report. In addition to these items, the noise measurement report should include tabulated values of the measured and rated noise levels for each measurement period. Comments should also be made regarding the variation of these descriptors throughout the measurement period.

Where 1/3 octave band or narrow band frequency analysis has been undertaken, the frequency spectra are to be included with the report. 1/3 octave band data should be submitted in both tabular and graphical format and reviewed using the template presented in Appendix VII of this document. Note that, in instances where extraneous noise sources (e.g. road traffic noise) dominate  $L_{eq}$  noise spectra, appropriate consideration may be given to the  $L_{F90}$  spectrum that may be more representative of site noise emissions alone.

Finally, the measurement report should include a statement of compliance, or otherwise, with the licence conditions along with clear statement of the levels of noise associated with the facility in question at the various measurement locations. In certain instances this will require detailed review of the noise levels and a simple statement of the measured noise level will not suffice.

**Table 6 Checklist for Noise Measurement Reports**

Item	Included
	Yes (✓)
Manufacturer, model type and serial number of the sound level meter, calibrator and microphone used for annual survey.	<input type="checkbox"/>
The type of windshield and other microphone attachments used.	<input type="checkbox"/>
The date the equipment was last calibrated to a traceable standard.	<input type="checkbox"/>
A statement of on-site calibration before and after the measurements.	<input type="checkbox"/>
The frequency weighting networks and meter response time (i.e. fast or slow).	<input type="checkbox"/>
A description of the measurement site and of the range of sound sources including the type of sound (continuous, intermittent, impulsive, tonal).	<input type="checkbox"/>
Measures to exclude extraneous noise and reference to the methodologies followed throughout the survey.	<input type="checkbox"/>
A map of the measurement site showing the locations of the measurement positions.	<input type="checkbox"/>
Photographs illustrating the positioning of the sound level meter (recommended but optional).	<input type="checkbox"/>
Details of the intervening ground between sources and measurement positions and the presence of barriers etc.	<input type="checkbox"/>
The time and date of the measurement.	<input type="checkbox"/>
A description of the meteorological conditions.	<input type="checkbox"/>
The background noise level (where practicable).	<input type="checkbox"/>
Details of steps taken to reduce uncertainty.	<input type="checkbox"/>
The names of the person/s that undertook the survey and drafted the survey report.	<input type="checkbox"/>

## 8. NOISE CONTROL AND MITIGATION MEASURES

### 8.1 Framework for Noise Mitigation Measures

The mitigation or amelioration of the degree of environmental impact is a prerequisite for a wide range of emissions. Mitigation measures can be broadly classified into avoidance (i.e. using an alternative approach to eliminate an impact) or reduction (reducing the severity of an impact). Environmental mitigation measures may include any of the following:

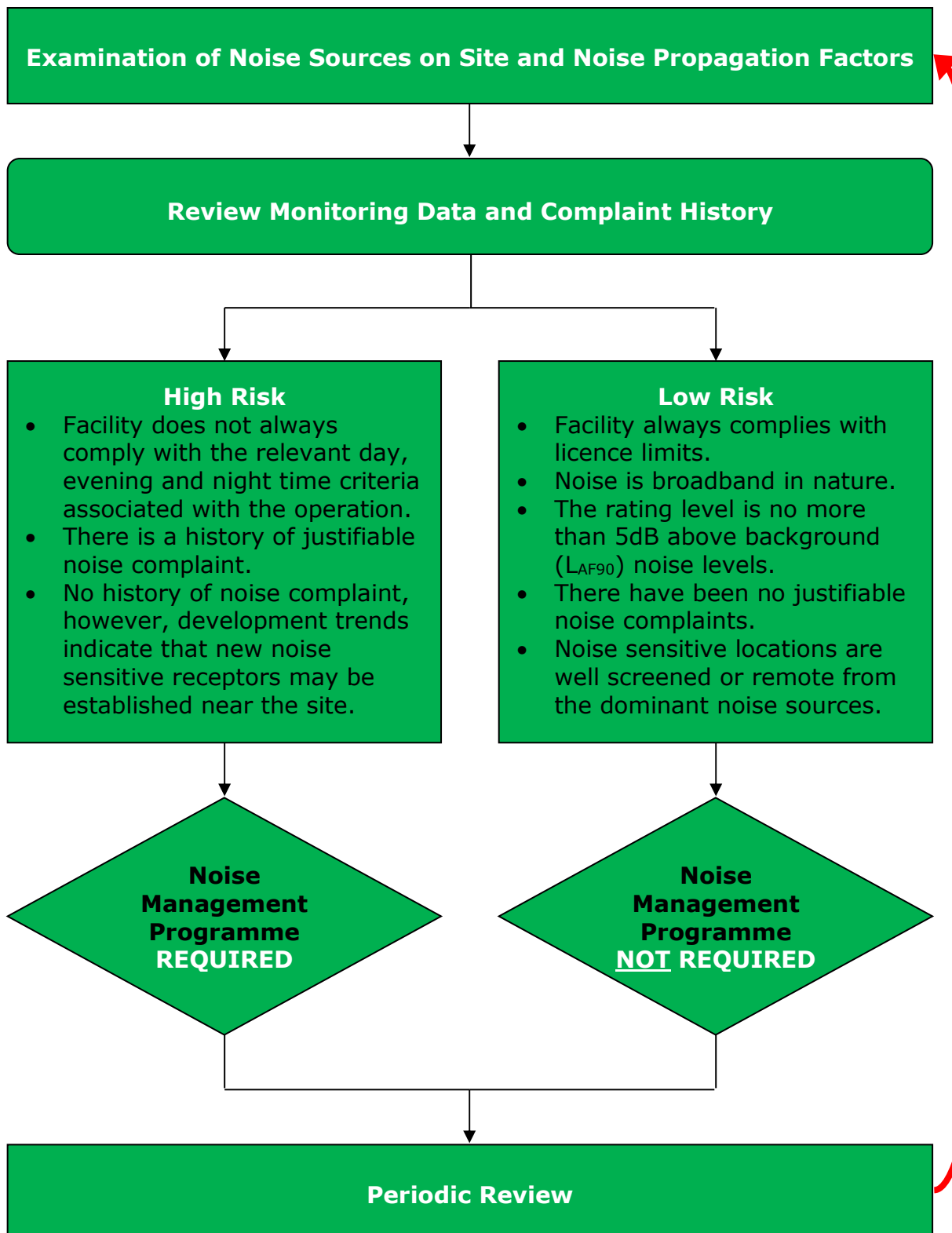
- Process alterations to reduce emissions;
- The installation or alteration of control equipment;
- Restricting the hours or intensity of operation of a plant, and;
- Modifying site or plant layouts, discharge points etc. to reduce the impact of emissions.

Mitigation measures themselves can occasionally have secondary impacts and these need to be identified and evaluated before implementation (e.g. fitting an acoustic attenuator or other control mechanism may impact the performance of certain equipment or may result in reduced energy efficiency).

The identification and application of mitigation measures should be considered during the planning and/or environmental impact assessment stage of a project. In many instances, however, there will be a requirement for ongoing management and control of noise over the lifespan of the site.

At some sites a combination of factors (e.g. inherently quiet plant or activities and/or effective containment of noisy sources) ensures that environmental noise is a relatively minor issue and significant noise impacts are unlikely to arise. However, many plants will require an ongoing programme of work to ensure an effective level of control over the facility's noise emissions. To this end it is considered appropriate that a Noise Management Programme be adopted for most sites based on a risk assessment approach. Some of the factors addressed in Section 4.1 will help to determine the nature and extent of the Noise Management Programme. The degree of attention and priority that the programme will require will also be determined on a site-specific, risk assessment based approach.

The majority of sites can be categorised as Low Risk or High Risk with regard to noise and an indication of some of the pertinent considerations is presented in a schematic in Figure 6. Rather than serve as a rigid tool for classifying each site, the schematic should be used to assist licensees and enforcement officers to assess the level of risk.

**Figure 6 Factors to Consider in the Development of a Noise Management Plan**

Many facilities will require some form of Noise Management Programme and only in exceptional cases will a dedicated programme not be required. As a general guide, a Noise Management Programme will typically not be required if:

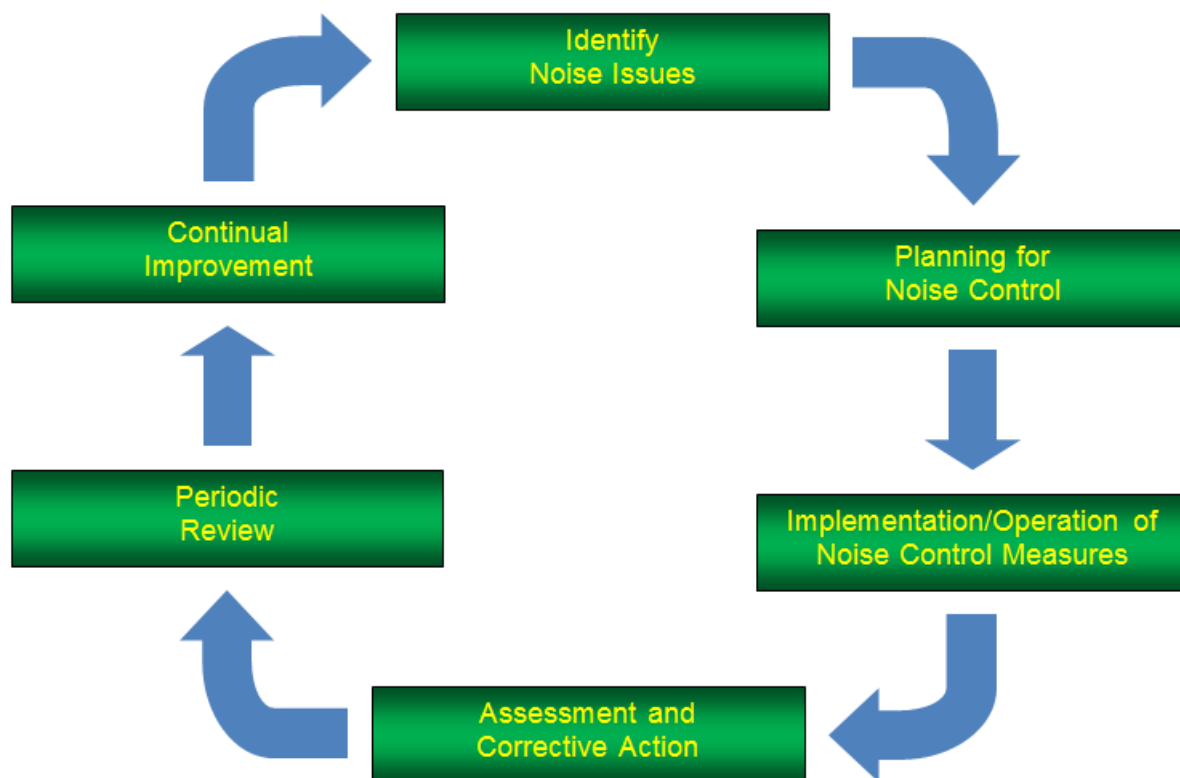
- Noise emissions attributable to the facility are in full compliance with the relevant site-specific limits;
- The site-specific noise is broadband in nature, i.e. there is a complete absence of tonal and impulsive noise, as determined by subjective and objective assessment, at the facility's site boundary and NSL's, and;
- There is no history of noise complaints from nearby sensitive receptors.

Should these conditions not apply, it should be generally assumed that a Noise Management Programme will be required, the scope and extent of which should be proportionate to the degree of risk pertaining to the facility.

Even when a site is considered to be low risk with regard to noise, ongoing regard must be had in relation to noise emissions as part of an integrated approach to pollution prevention and control. In this regard it is noteworthy that in many instances the installation of new plant, such as atmospheric abatement, air handling equipment or waste management plant, may give rise to significant new noise emissions.

A Noise Management Programme can be defined as that part of the overall management system that addresses the environmental noise issues pertaining to an activity. The environmental management system approach to continuous improvement is widely practiced and an adaptation of the ISO 14001 EMS system model for continual improvement is appropriate (see Figure 7).

**Figure 7 Noise Management Flow Chart**





## 8.2 Options for Noise Control and Mitigation

Noise mitigation and control measures can be broadly classified into: planning and management techniques, the control of noise at source and the control of noise propagation. In practice, a mixture of measures is typically required in order to achieve the desired results. It is considered that, in almost every instance where there is a requirement to reduce noise emissions, specialist advice will be required. Accordingly, it is beyond the scope of this document to provide detailed guidance in relation to this issue, although some examples of good practice and potential control approaches are given below; additional information is provided in Appendix IX.

In ideal circumstances, noise control will be considered during the planning stages of a site. This will permit the amelioration of noise emissions through zoning (keeping noisy processes screened or well away from sensitive locations) and selection of quieter processes and plant. If these measures alone are not sufficient, it will be necessary to implement other noise control measures accordingly.

The control of noise at source is an effective means of treating a noise source and will typically involve physical changes, modification of processes or administrative controls. The first step is identify the cause of the noise in question (e.g. impact noise, out-of-balance forces, stick-slip friction, hydraulic effects or aerodynamic noise), following which the most appropriate controls may be put in place.

Noise may also be controlled by altering its propagation path through the use of various techniques. The most common measures include acoustic enclosures, acoustic door sets, lagging materials, noise barriers, attenuators, damping treatments and vibration isolators.

## 9. COMPLAINT INVESTIGATION

Licence conditions will generally require all environmental noise complaints to be logged and investigated (see Appendix X). The licensee must comply with the conditions specified in the licence relating to the handling and recording of complaints. In the first instance complaints can sometimes be avoided by proactive and systematic assessment procedures (e.g. identifying when machinery and plant is out of balance) before the impact at an NSL becomes problematic. Once a complaint has been made to a licensee, a detailed record of all pertinent information should be logged by the licensee, including:

- Name and address of complainant;
- Time and date complaint was made;
- Date, time and duration of noise and characteristics e.g. rumble, clatters, intermittent screeching, etc.;
- Details on whether neighbours or other family members have heard the noise;
- Likely cause or source of the noise;
- Weather conditions, in particular wind speed and direction (for intermittent noise sources, especially when the NSL is a considerable distance from the offending noise source, meteorological conditions can be a determining factor), and;
- Investigative and follow-up action arising from the complaint.

In all cases an investigation should be undertaken promptly (typically within two weeks or sooner where a noise issue is persistent) and the complainant should be notified in writing of the findings. Details of any remedial work should also be communicated to the complainant along with a timeframe for implementation.

Where there may be a question as to the *bona fides* of the complaint or any residual dispute following an initial investigation, an objective assessment should be undertaken in accordance with the guidance set out in BS 4142: 2014: *Methods for rating and assessing industrial and commercial sound*. This standard provides a comprehensive mechanism for measuring noise levels along with guidance relating to their assessment. Note that BS 4142 emphasises the experience and judgement of the practitioner conducting the assessment, who should be fully competent in this regard; the Agency considers that this is an issue of particular importance, given BS 4142's reliance on subjective methods of assessment. Careful consideration should be given to the appropriate assignation of rating penalties for tonality and impulsivity in the context of the procedures described in Section 5. Annex A to BS 4142 contains a number of highly informative examples that serve to provide guidance on the appropriate derivation of rating levels.

In situations where there are reasonable grounds for annoyance and/or licence limits are exceeded, prompt remedial action should be taken by the licensee and BAT should be used to resolve the problem and to minimise the noise impact (see Section 1.4).

Appendix X provides a typical standard form to illustrate the key information that should be sought from a complainant in order to assist in the assessment of the issue. It should be noted that failure of an operator to engage early with an issue can result in the opportunity to address the issue at an early stage being missed, resulting in further complaints and a situation where complaints become more strident due to a perceived lack of action.

## 10. SPECIFIC ACTIVITIES

### 10.1 Quarrying and Mining Operations

Detailed guidance in relation to noise and vibration associated with these activities is provided in the Agency publication *Environmental Management in the Extractive Industry*<sup>24</sup> (available on the Agency website [www.epa.ie](http://www.epa.ie)). Section 3.5 *Noise & Vibration* of this document sets out appropriate Emission Limit Values (ELV's) and deals with control of noise, vibration and air overpressure.

### 10.2 Wind Turbines

Refer to Agency publication *Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites* (NG3), which provides:

- Guidance on assessing the potential noise impact on NSL's from wind turbines on Agency licensed sites, and;
- A noise impact assessment methodology to ensure that all data generated is reliable and that resultant recommendations are fully justifiable.



### 10.3 Waste Related Operations

Noise is produced during the acceptance, handling and processing of waste at landfills, waste transfer stations, MRF's and waste treatment facilities and during the removal of wastes off-site. In this instance it is considered that traffic movements associated with the waste facility on the public road network are an issue for the relevant local authority.

Typical sources of noise would include:

- Vehicle and plant movements on site associated with the delivery of waste;
- Movement of plant around the site, including reversing alarms;
- Deposition, compaction, loading, sorting and covering of waste;
- The construction of new landfill cells and the capping and restoration of filled cells;
- Localised noise emissions on an intermittent basis e.g. vehicle and wheel cleaning, lifting operations, generators;
- Fixed plant such as landfill gas flares, leachate treatment equipment, shredders, trommels, compactors, picking lines and bailers, and;
- Emission control equipment such as negative air pressure systems.

All landfills must be operated in accordance with the conditions of a waste licence from the Agency. The waste licence typically includes requirements for site specific noise measurements and generally sets out emission limit values for noise emissions from the facility.

The larger examples of other waste facilities fall within the waste licensing regime and controls on the noise emissions from these facilities are typically specified in the waste licence.

An effective Noise Management Programme for a waste facility will typically require detailed consideration of a variety of noise control measures. Many of the general noise control techniques referred to in Section 8.0 are directly applicable to these types of site. Some of the key measures are summarized below.

- Fixed plant should be located as far away as possible from noise sensitive receptors;
- Use buildings to contain noisy fixed plant and undertake noisy activities indoors, where practicable;
- Employ noise reducing technologies, such as attenuators or enclosures, where practicable;
- Ensure that any noise control measures are maintained as per the manufacturers' requirements;
- Use screens around plant or equipment, and;
- Ensure that enclosures and doors/windows are properly sealed and/or closed.

In addition, traffic management can often be the cornerstone to good noise control. Accordingly, some traffic management measures are outlined below.

- Minimise the number of vehicles/heavy plant on site at any one time;
- Maintain vehicles in good order, employ the principles of preventive maintenance and undertake reference vehicle noise measurements at defined intervals;
- Ensure that noisy vehicles are parked as far as possible from noise sensitive areas;
- Switch off idling engines where possible and prevent excessive revving;
- Maintain road surfaces in good order;
- Ensure that drivers are aware of the potential for noise to cause annoyance/disturbance to local residents – they should show due regard to this, particularly when entering and leaving the site (e.g. no unnecessary horn blowing), and;
- Consider the use of alternative varieties of reversing alarm with reduced noise output, such as ambient noise sensing alarms with variable volume or directional modulated alarms – these must be evaluated on a case-by-case basis and regard must be had to any health and safety issues that may arise.

Noise is liable to give rise to complaints whenever the level exceeds the pre-existing level by a certain margin or whenever it exceeds certain absolute levels. Given that these sites, particularly landfills, are often located in relatively remote areas likely to have low background noise levels, extra vigilance is required whenever noisy plant is operating close to the site boundaries and/or noise sensitive receptors. In such circumstances it may be possible to secure some relaxation in the typical noise limits imposed by the facility's licence. However, at all times regard must be had to the potential off-site impact and appropriate controls must be adopted. Minimizing the early morning and late evening operational hours will be essential in many cases and the development of good communications with neighbouring residents is often helpful.

## 11. OTHER GUIDANCE

The content of this document has been developed specifically for operations that fall under the IPPC and Waste Licensing functions of the Agency. In certain other instances the approach to identifying appropriate criteria outlined in this document may be considered suitable, however, the use of this methodology should be considered and justified by a competent person.

There are numerous standards and guidance documents that may be of use in the assessment of noise in situations that do not fall under the remit of the Agency. Some of these documents are discussed in the following section. Note that this list is by no means considered exhaustive and a competent person should be retained to develop a suitably robust noise assessment protocol for the issue in question.

### BS 4142: 2014: Methods for rating and assessing industrial and commercial sound

BS 4142: 2014 describes a method for assessing industrial, commercial and background noise levels in order to assess the likely effects on people who might be inside or outside a dwelling or premises used for residential purposes. Various key elements of this standard are addressed elsewhere in this document.

### BS 5228-1: 2009 + A1: 2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise

BS 5228<sup>25</sup> provides guidance on the control of noise from construction and open sites. It also provides guidance on the calculation of noise from other sites within the scope of the standard. The calculation method may be of assistance in terms of IPPC and Waste sites. It could be used to predict noise at open sites, particularly landfill and quarry sites. Although other methods require the use of frequency analysis, BS 5228 Pt. 1 allows for the use of A-weighted levels, which is likely to make it easier to apply in practice. However, care must be taken since it does not specifically take account of tonal elements in a noise source.

### BS 8233: 2014 Guidance on sound insulation and noise reduction for buildings

BS8233<sup>26</sup> offers advice on the control of noise in and around buildings. It offers straightforward and outline guidance on noise matters, but focuses on noise within buildings and the insulation offered by buildings.

### Wind Energy Development Guidelines (DoEHLG)

For appropriate guidance in relation to the assessment of wind turbines that do not fall under the remit of the Agency, consideration should be given to Section 5.6 of the *Wind Energy Development Guidelines*<sup>27</sup> published by the Department of the Environment, Heritage and Local Government. This document outlines the appropriate noise criteria in relation to wind farm developments.

Note that, as of the date of publication, a number of the documents referred to above are under review. Advice should be sought from a competent person in relation to the applicability of the documents identified in this section.

**APPENDIX I: GLOSSARY OF ACOUSTIC TERMINOLOGY**

<b>ambient noise</b>	The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.
<b>acoustic shadow</b>	An acoustic shadow is an area through which sound waves fail to propagate, due to topographical obstructions or disruption of the waves via phenomena such as wind currents.
<b>background noise</b>	The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T ( $L_{AF90,T}$ ).
<b>broadband</b>	Sounds that contain energy distributed across a wide range of frequencies.
<b>competent person</b>	Individual possessing a combination of technical knowledge, experience and skills as outlined in Section 2.0 and who can demonstrate both practical and theoretical competence.
<b>criterion noise level</b>	The long-term mean value of the noise level that must not be exceeded. This is generally stipulated in the IPPC/Waste licence and it may be applied to a noise source, a boundary of the activity or to an NSL in the vicinity of the site.
<b>dB</b>	Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the <b>RMS</b> pressure of the sound field and the reference pressure of 20 micropascals (20 $\mu$ Pa).
<b>façade level</b>	The noise level at a location 1m from the façade of a building is described by the term façade level, and is subject to a higher noise level than one in an open area (free-field conditions) due to reflection effects.
<b>free-field</b>	These are conditions in which the radiation from sound sources is unaffected by the presence of any reflecting boundaries or the source itself. In practice, it is a field in which the effects of the boundaries are negligible over the frequency range of interest. In environmental noise, true free-field measurement conditions are seldom achieved and generally the microphone will be positioned at a height between 1.2 and 1.5 metres above ground level. To minimise the influence of reflections, measurements are generally made at least 3.5 metres from any reflecting surface other than the ground.
<b>Hertz (Hz)</b>	The unit of sound frequency in cycles per second.
<b>impulsive</b>	A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.

<b>L<sub>Aeq,T</sub></b>	This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T). The closer the L <sub>Aeq</sub> value is to either the L <sub>AF10</sub> or L <sub>AF90</sub> value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources, such as traffic, on the background.
<b>L<sub>AFN</sub></b>	The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.
<b>L<sub>Ar,T</sub></b>	The Rated Noise Level, equal to the L <sub>Aeq</sub> during a specified time interval (T), plus specified adjustments for tonal character and/or impulsiveness of the sound.
<b>L<sub>AF10</sub></b>	Refers to those A-weighted noise levels in the top 10 percentile of the sampling interval; it is the level which is exceeded for 10% of the measurement period. It is used to determine the intermittent high noise level features of locally generated noise and usually gives an indicator of the level of road traffic. Measured using the "Fast" time weighting.
<b>L<sub>AF90</sub></b>	Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to describe a background level. Measured using the "Fast" time weighting.
<b>L<sub>AFmax</sub></b>	The maximum <b>RMS</b> A-weighted sound pressure level occurring within a specified time period. Measured using the "Fast" time weighting.
<b>L<sub>AFmin</sub></b>	The minimum <b>RMS</b> A-weighted sound pressure level occurring within a specified time period. Measured using the "Fast" time weighting.
<b>L<sub>den</sub></b>	Is the 24 hour noise rating level determined by the averaging of the L <sub>day</sub> with the L <sub>evening</sub> plus a 5 dB penalty and the L <sub>night</sub> plus a 10 dB penalty. L <sub>den</sub> is calculated using the following formula:

$$L_{den} = 10 \log \left( \frac{1}{24} \right) \left( 12 * \left( 10^{\frac{L_{day}}{10}} \right) + 4 * \left( 10^{\frac{L_{evening}+5}{10}} \right) + 8 * \left( 10^{\frac{L_{night}+10}{10}} \right) \right)$$

Where:

- L<sub>day</sub> is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the day periods of a year;
- L<sub>evening</sub> is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the evening periods of a year and;
- L<sub>night</sub> is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the night periods of a year.



<b>low background noise</b>	<p>In the context of this guidance, an area of low background noise is one where the existing background noise levels measured during an environmental noise survey are as follows:</p> <ul style="list-style-type: none"> <li>○ Average Daytime Background Noise Level <math>\leq 40\text{dB } L_{AF90}</math>, and;</li> <li>○ Average Evening Background Noise Level <math>\leq 35\text{dB } L_{AF90}</math>, and;</li> <li>○ Average Night-time Background Noise Level <math>\leq 30\text{dB } L_{AF90}</math>.</li> </ul>
<b>low frequency noise</b>	LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum; see Appendix VI for a more detailed discussion.
<b><math>L_{pA}</math> (dB)</b>	An 'A-weighted decibel' - a measure of the overall level of sound across the audible frequency range (20Hz – 20kHz) with A-frequency weighting (i.e. 'A-weighting') to compensate for the varying sensitivity of the human ear to sound at different frequencies.
<b>noise</b>	Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a person exposed to it, or any sound that could cause actual physiological harm to a person exposed to it, or physical damage to any structure exposed to it, is known as noise.
<b>noise sensitive location</b>	NSL – any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.
<b>octave band</b>	A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.
<b>rating level</b>	See $L_{Ar,T}$ .
<b>RMS</b>	The RMS (Root Mean Square) value of a set of numbers is the square root of the average of their squares.
<b>SEL (<math>L_{Ax}</math> or <math>L_{AE}</math>)</b>	Sound exposure level – a measure of the A-weighted sound energy used to describe noise events such as the passing of a train or aircraft; it is the A-weighted sound pressure level if occurring over a period of 1 second, would contain the same amount of A-weighted sound energy as the event.
<b>sound power level</b>	The logarithmic measure of sound power in comparison to a referenced sound intensity level of one picowatt (1pW) per $\text{m}^2$ where:

$$L_w = 10 \log \frac{W}{W_0} \text{ dB}$$

Where:  $W$  is the rms value of sound power in pascals; and  
 $W_0$  is 1 pW.

**sound pressure level** Sound pressure refers to the fluctuations in air pressure caused by the passage of a sound wave. It may be expressed in terms of sound pressure level at a point, which is defined as:

$$L_p = 20 \log \frac{P}{P_0} \text{ dB}$$

Where: P is the sound pressure;  
P<sub>0</sub> is a reference pressure for propagation of sound in air and has a value of 2x10<sup>-5</sup>Pa.

**specific noise level** A component of the ambient noise which can be specifically identified by acoustical means and may be associated with a specific source. In BS 4142, there is a more precise definition as follows: 'equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T<sub>r</sub>.'

**time weighting** One of the averaging times (Fast, Slow or Impulse) used for the measurement of RMS sound pressure level in sound level meters.

**tonal** Sounds which cover a range of only a few Hz which contains a clearly audible tone, i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.

**1/3 octave analysis** Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one-third of an octave each.

## APPENDIX II: QUIET AREA SCREENING TEMPLATE

Site Details	
Site Name	
Licence Application Reference	
Site Address	

Quiet Area Screening of the Development Location		
Screening Question	Answer (Yes/No)	
Is the site >3km away from urban areas with a population >1,000 people?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is the site >10km away from urban areas with a population >5,000 people?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is the site >15km away from urban areas with a population >10,000 people?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is the site >3km away from any local industry?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is the site >10km away from any major industry centre?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is the site >5km away from any national primary route?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is the site >7.5km away from any motorway or dual carriageway?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
QUIET AREA?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Other Relevant Comments		

### APPENDIX III: QUIET AREA BASELINE SURVEY TEMPLATE

Quiet Area Baseline Survey – Set up of Equipment			
Date (dd/mm/yy)			
Start Time (hh:mm)			
Noise Meter Location National Grid Reference (E, N – 6 digit reference in metres)			
Noise Meter set to record	LAeq	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	LA <sub>F90</sub>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	LA <sub>Fmax</sub>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	LA <sub>Fmin</sub>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	At 15 minute intervals	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	Set to nearest 15 minute period	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Noise meter calibration date (dd/mm/yy)			
Noise calibrator calibration date (dd/mm/yy)			
Noise meter check calibrated		Before <input type="checkbox"/>	After <input type="checkbox"/>
Met Logger set to record	Wind speed (m/s)	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	Wind direction (degrees)	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	Rainfall (mm)	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	At 15 minute intervals	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	Set to nearest 15 minute period	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Met logger calibration date (dd/mm/yy)		Yes <input type="checkbox"/>	No <input type="checkbox"/>
Set Up By:	Name (Block Letters)		
	Position		
	Signed		

Quiet Area Baseline Survey – Collection of Monitoring Equipment	
Note any issues on collection of noise equipment (such as power off, movement of microphone, evidence of tampering)	
Collected By:	Name (Block Letters)
	Position
	Signed

## Data Analysis

1. Combine noise data with meteorological data.
2. Remove data corresponding to periods of rainfall.
3. Remove data corresponding to periods where wind speeds exceed 5m/s.
4. Segregate data into daytime (07:00 to 19:00hrs), evening time (19:00 to 23:00hrs) and night-time (23:00 to 07:00hrs).
5. Correlate noise data with wind data standardised to 10 metre height and calculate best fit polynomial (2<sup>nd</sup> or 3<sup>rd</sup> order) regression line through data. If there is no relation between noise and wind speed straightforward averaging may be used. Append analysis to this document.
6. Determine the arithmetic average background noise level ( $L_{AF90}$ ) for each time period at each wind speed integer values (1m/s, 2m/s) from the correlated noise data produced in Step 5.
7. Reproduce analysis for each receiver location.
8. Save file as read-only to prevent tampering.

Reporting (To be completed for each Location)					
	dB at Wind Speed (m/s)				
Receiver :	<1	2	3	4	5
Average Daytime Level, dB $L_{AF90}$					
Average Evening Level, dB $L_{AF90}$					
Average Night-time Level, dB $L_{AF90}$					
Daytime Criterion, dB $L_{Ar,T}$					
Evening Criterion, dB $L_{Ar,T}$					
Night-time Criterion, dB $L_{Aeq,T}$					
Reported By:	Name (Block Letters)				
	Position				
	Signed				

## APPENDIX IV: NON-QUIET AREA BASELINE NOISE SURVEY TEMPLATE

<b>Site Details</b>	
<b>Site Name</b>	
<b>Licence Application Reference</b>	
<b>Site Address</b>	

<b>Baseline Noise Survey - Set up of Equipment</b>				
<b>Date (dd/mm/yy)</b>				
<b>Start Time (hh:mm)</b>				
<b>Noise Meter set to record</b>	<b>L<sub>Aeq</sub></b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
	<b>L<sub>AF90</sub></b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
	<b>L<sub>AFmax</sub></b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
	<b>Set to record L<sub>Leq</sub> in 1/3 octaves</b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
	<b>At 15 minute intervals</b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
	<b>Set to nearest 15 minute period</b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
<b>Noise meter calibration date (dd/mm/yy)</b>				
<b>Noise calibrator calibration date (dd/mm/yy)</b>				
<b>Noise meter check calibrated</b>		Before <input type="checkbox"/>	After <input type="checkbox"/>	
<b>Wind Speed Data</b>	<b>Equipment:</b>		<b>Start of Survey</b>	<b>End of Survey</b>
<b>Average Wind speed (m/s)</b>				
<b>Wind direction (degrees)</b>				
<b>Set Up By:</b>	Name (Block Letters)			
	Position			
	Signed			

### Data Processing

1. Segregate data into daytime (07:00 to 19:00hrs), evening time (19:00 to 23:00hrs) and night-time (23:00 to 07:00hrs).
2. Determine the average background noise level (L<sub>AF90</sub>) for each time period using the results for each sample measurement.
3. Reproduce analysis for each receiver location.
4. Save file as read-only to prevent tampering.

Receiver:					
Period	Time	Measured Noise Levels (dB re. $2 \times 10^{-5}$ Pa)			Comments
		L <sub>Aeq</sub>	L <sub>AFmax</sub>	L <sub>AF90</sub>	
Daytime					
	Arithmetic Average of L <sub>AF90</sub> (dB)				
	Daytime Criterion, dB L <sub>Ar,T</sub>				
Evening					
	Arithmetic Average of L <sub>AF90</sub> (dB)				
	Evening Criterion, dB L <sub>Ar,T</sub>				
Night-time					
	Arithmetic Average of L <sub>AF90</sub> (dB)				
	Night-time Criterion, dB L <sub>Aeq,T</sub>				
Reported By:	Name (Block Letters)				
	Position				
	Signed				



## APPENDIX V: NOISE CRITERION SELECTION EXAMPLES

### EXAMPLE OF QUIET AREA

Quiet Area Survey – Set up of Equipment			
Date (dd/mm/yy)		15/06/2011	
Start Time (hh:mm)		16:00	
Noise Meter Location National Grid Reference (E, N – 6 digit reference in metres)		123,456	654,321
Noise Meter set to record	L <sub>Aeq</sub>	Yes ✓	No <input type="checkbox"/>
	L <sub>AF90</sub>	Yes ✓	No <input type="checkbox"/>
	L <sub>AFmax</sub>	Yes ✓	No <input type="checkbox"/>
	L <sub>AFmin</sub>	Yes ✓	No <input type="checkbox"/>
	At 15 minute intervals	Yes ✓	No <input type="checkbox"/>
	Set to nearest 15 minute period	Yes ✓	No <input type="checkbox"/>
Noise meter calibration date (dd/mm/yy)		01/05/2010	
Noise calibrator calibration date (dd/mm/yy)		01/05/2010	
Noise meter check calibrated		Before ✓	After ✓
Met Logger set to record	Wind speed (m/s)	Yes ✓	No <input type="checkbox"/>
	Wind direction (degrees)	Yes ✓	No <input type="checkbox"/>
	Rainfall (mm)	Yes ✓	No <input type="checkbox"/>
	At 15 minute intervals	Yes ✓	No <input type="checkbox"/>
	Set to nearest 15 minute period	Yes ✓	No <input type="checkbox"/>
Met logger calibration date (dd/mm/yy)		01/05/2010	
Set Up By:	JOHN SMYTH		Name (Block Letters)
	Acoustic Consultant		Position
			Signed

Quiet Area Survey – Collection of Monitoring Equipment	
Note any issues on collection of noise equipment (such as power off, movement of microphone, evidence of tampering)	No issues.
Collected By:	JOHN SMITH Name (Block Letters)
	Acoustic Consultant Position
	Signed

Reporting (To be completed for each Location)					
	dB at Wind Speed (m/s)				
Receiver :	<1	2	3	4	5
Average Daytime Level, dB L <sub>AF90</sub>	22	22	23	25	28
Average Evening Level, dB L <sub>AF90</sub>	20	20	21	23	25
Average Night-time Level, dB L <sub>AF90</sub>	18	18	19	20	22
Daytime Criterion, dB L <sub>Ar,T</sub>	14				
Evening Criterion, dB L <sub>Ar,T</sub>	12				
Night-time Criterion, dB L <sub>Aeq,T</sub>	9				
Reported By:	JOHN SMITH Name (Block Letters)				
	Acoustic Consultant Position				
	Signed				

## EXAMPLE OF AREA OF LOW BACKGROUND NOISE

Noise Survey - Set up of Equipment				
Date (dd/mm/yy)			12/06/2011	
Start Time (hh:mm)			10:00	
Noise Meter set to record	L <sub>Aeq</sub>		Yes ✓	No <input type="checkbox"/>
	L <sub>AF90</sub>		Yes ✓	No <input type="checkbox"/>
	L <sub>AFmax</sub>		Yes ✓	No <input type="checkbox"/>
	Set to record L <sub>Leq</sub> in 1/3 octaves		Yes ✓	No <input type="checkbox"/>
	At 15 minute intervals		Yes ✓	No <input type="checkbox"/>
	Set to nearest 15 minute period		Yes ✓	No <input type="checkbox"/>
Noise meter calibration date (dd/mm/yy)			01/05/2010	
Noise calibrator calibration date (dd/mm/yy)			01/05/2010	
Noise meter check calibrated			Before ✓	After ✓
Wind Speed Data	Equipment:	Kestrel Hand Held Anemometer	Start of Survey	End of Survey
Average Wind speed (m/s)			2.2m/s	3.1m/s
Wind direction (degrees)			Southerly (180°)	Southerly (180°)
Set Up By:	JOHN SMITH		Name (Block Letters)	
	Acoustic Consultant		Position	
			Signed	

Receiver:	Location 1 – to the south west some 200m from proposed boundary line				
Period	Time	Measured Noise Levels (dB re. $2 \times 10^{-5}$ Pa)			Comments
		L <sub>Aeq</sub>	L <sub>AFmax</sub>	L <sub>AF90</sub>	
Daytime	10:34 – 10:49	43	63	38	Ambient noise levels dictated by occasional steam release.
	11:52 – 12:07	43	65	38	
	12:50 – 13:05	44	68	39	Max level associated with traffic movement.
	14:10 – 14:25	43	65	38	Background noise dictated by broadband emissions from ACME plant.
	Arithmetic Average of L <sub>AF90</sub> (dB)			38	
	Daytime Criterion, dB L <sub>Ar,T</sub>			45	
Evening	19:34 – 19:49	38	63	31	ACME plant not operating.
	20:52 – 21:07	36	55	29	Max level associated with traffic movement.
	21:50 – 22:05	36	61	31	
	Arithmetic Average of L <sub>AF90</sub> (dB)			30	Background noise dictated by distant road traffic noise and a low level of wind noise in foliage.
	Evening Criterion, dB L <sub>Ar,T</sub>			40	
Night-time	23:05 – 23:20	34	46	26	Max level associated with car parking at nearby residence.
	00:15 – 00:30	35	47	25	
	01:15 – 01:30	33	43	23	Background noise dictated by distant road traffic and low degree of wind generated noise.
	Arithmetic Average of L <sub>AF90</sub> (dB)			25	
	Night-time Criterion, dB L <sub>Aeq,T</sub>			35	
Reported By:	John Smith				Name (Block Letters)
	Acoustic Consultant				Position
					Signed

## APPENDIX VI: LOW FREQUENCY NOISE

**Low Frequency Noise** (LFN) is not clearly defined but it is generally taken to mean noise below a frequency of about 100 to 150Hz, and is usually associated with noise in the 40 to 60Hz range.

Many of the assessment and control techniques which pertain to everyday noise sources do not apply to low frequency noise. In 2005 a report entitled *Proposed criteria for the assessment of low frequency noise disturbance*<sup>28</sup> was produced by Salford University under contract to the UK Department for Environment, Food and Rural Affairs (DEFRA). The publication was designed to provide an update of the current information available concerning low frequency noise and to provide assistance for those involved in low frequency noise issues. While reference should be made to the original text, a summary of the main guidance is provided below.

### General

The human ear, for the majority of people, is not very sensitive at low frequencies. At low levels of noise, the human ear attenuates sound by about 25dB at 100Hz, 40dB at 50Hz, and 70dB at 20Hz. While hearing deteriorates more rapidly at the mid and higher frequency, generally older peoples' hearing tends to be proportionately more acute at low frequencies. Some of the problems pertaining to low frequency noise are associated with the fact that mid and high frequency noise is attenuated by propagation through atmosphere and by ground effects. In some instances this results in an emphasising of the low frequency noise content. In addition resonance can be set up inside a room with nodes (quiet points) and anti-nodes (loud points) dependent on the room dimensions and the frequency of the noise. These room resonances can cause elevated levels of low frequency noise at certain locations within a room.

### Sources

Possible sources of LFN include industrial and/or commercial plant and equipment (e.g. pumps, fans, cooling towers), electrical installations, wind farms, road, rail, sea or air traffic and amplified music. LFN can also be domestic in origin (e.g. refrigerators, oil fired burners). LFN can be easily transmitted through structures and airborne noise can cause windows and other elements to rattle. Thus the source's direction may be unclear and there may also be difficulty in deciding whether the noise is airborne or structure borne.

### Measurement and Assessment

The Salford University report recommends that in the first instance the noise levels in the room where there is a complaint of low frequency noise should be measured. The sound level meter should be set to linear and the  $L_{eq}$ ,  $L_{10}$  and  $L_{90}$  acoustic parameters should be measured over the frequency range of 10Hz to 160Hz in 1/3 octave bands. It should be noted that the person taking the measurements may not be able to hear the low frequency noise.

If the  $L_{eq}$  values measured over a time when the noise is said to be present exceed the values in the table below then the low frequency noise is said to be audible and could cause disturbance.

	Threshold of Hearing												
	1/3 <sup>rd</sup> Octave Band Centre Frequency, Hz												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB, $L_{eq}$	92	87	83	74	64	56	49	43	42	40	38	36	34

In trying to locate a source of LFN, it is recommended that the assessor should firstly try to determine if the source is within the building itself. This may require electrical items within the building to be turned off, e.g. refrigerators etc. If this does not identify the source then consideration should be given to external sources or sources in adjacent buildings.

A low frequency noise investigation protocol recommends investigators to assess the history of the nuisance including:

- When the LFN was first heard;
- The type of noise, its duration and frequency;
- The complainant's belief about the source;
- The effect of the noise on the complainant;
- Whether other family members hear it;
- Whether neighbours hear it, and;
- Whether the complainant believes they are particularly sensitive to other sources of noise.

The investigator should initially try to listen to the noise, then measure and assess the noise. The investigator should then try to locate the source and where necessary take appropriate action to resolve the problem. In certain situations, however, the identification of the source of LFN alone can prove to be hugely problematical.

**APPENDIX VII: TONAL NOISE ASSESSMENT TEMPLATE**

<b>Site &amp; Survey Details</b>			
<b>Site Name</b>			
<b>Application/Licence Reference</b>			
<b>Site Address</b>			
<b>Date (dd/mm/yy)</b>			
<b>Time (hh:mm)</b>			
<b>Noise Meter set to record</b>	<b>L<sub>Aeq</sub></b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	<b>L<sub>AF90</sub></b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	<b>L<sub>AFmax</sub></b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	<b>Set to record L<sub>Leq</sub> in 1/3 octaves</b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	<b>At 15 minute intervals</b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
	<b>Set to nearest 15 minute period</b>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<b>Noise meter calibration date (dd/mm/yy)</b>			
<b>Noise calibrator calibration date (dd/mm/yy)</b>			
<b>Noise meter check calibrated</b>		Before <input type="checkbox"/>	After <input type="checkbox"/>
<b>Average Wind speed (m/s)</b>			
<b>Wind direction (degrees)</b>			
<b>Set Up By:</b>	Name (Block Letters)		
	Position		
	Signed		

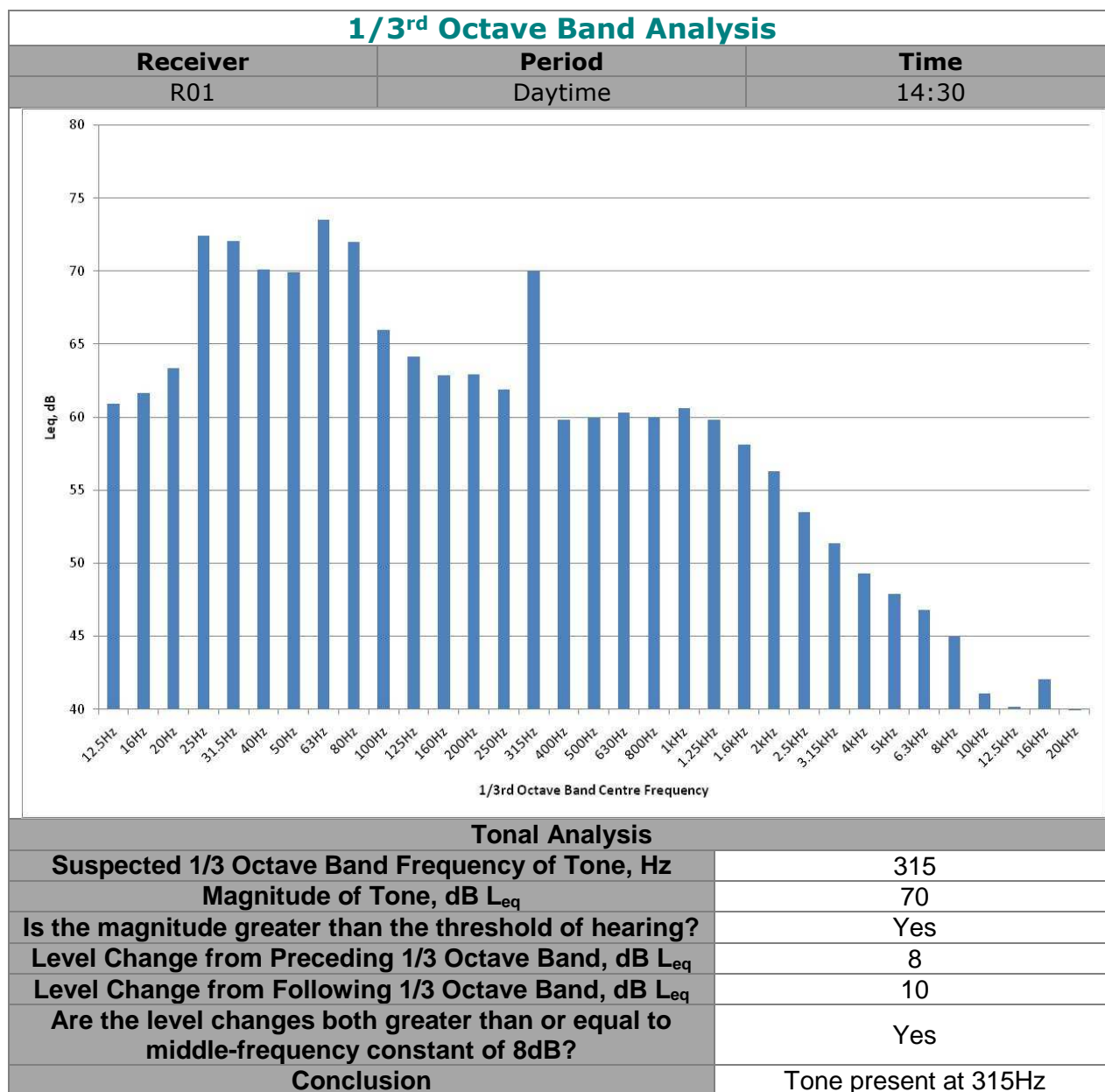
**Data Analysis**

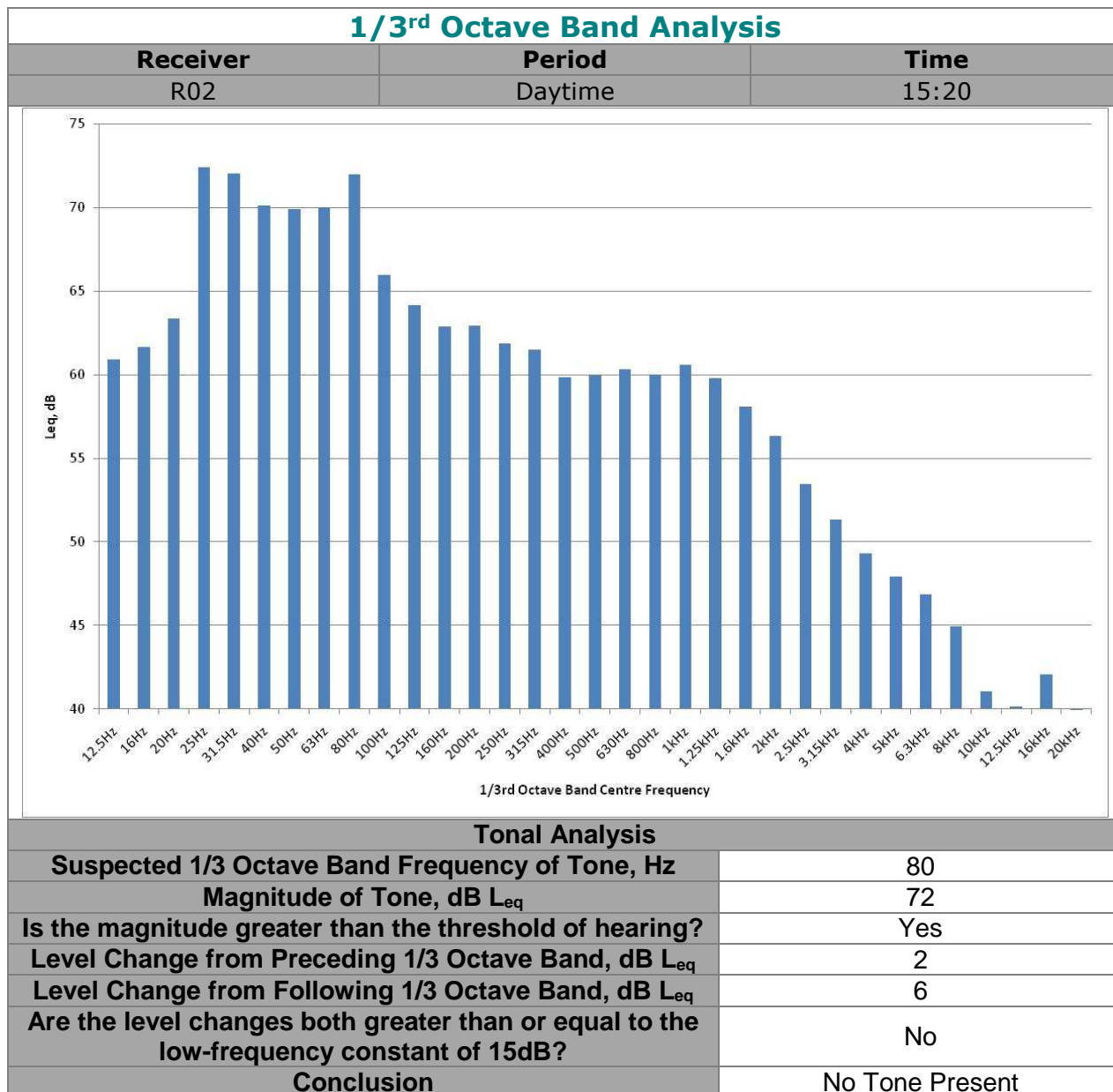
1. The un-weighted equivalent sound pressure level ( $L_{eq}$ ) measured in 1/3 octave bands should be graphed against frequency.
2. Tones should be obvious when examining the graphs produced in Step 1.
3. A tone is deemed to be present when the level difference between the  $L_{eq}$  at the 1/3 octave band of the tone and each adjacent 1/3 octave band is greater than or equal to 15dB for low-frequencies (25Hz to 125Hz), 8dB for middle-frequencies (160Hz to 400Hz) or 5dB for high-frequencies (500Hz to 10,000Hz).
4. If the tone frequency is less than 125Hz then care should be taken to ensure that the magnitude of the tone is above the threshold of hearing at the tonal frequency.
5. Reproduce analysis for each receiver location.
6. Save file as read-only to prevent tampering.

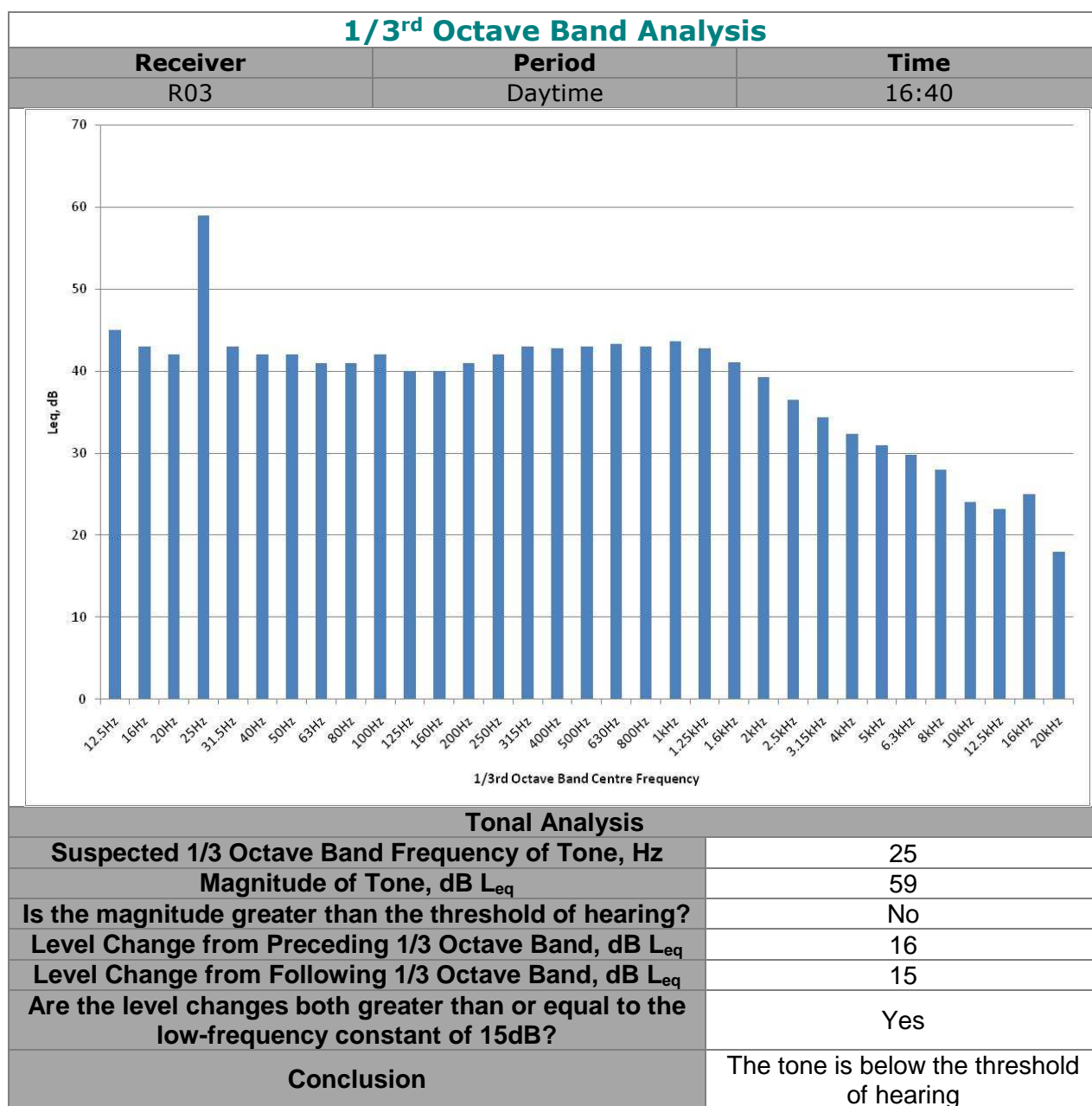


## Example Tonal Analysis Report

Site & Survey Details			
<b>Site Name</b>		ACME Industries	
<b>Application/Licence Reference</b>		IPPC 1234	
<b>Site Address</b>		Main Street	
<b>Date (dd/mm/yy)</b>			13 September 2011
<b>Start Time (hh:mm)</b>			14:30
<b>Noise Meter set to record</b>	<b>L<sub>Aeq</sub></b>	Yes ✓	No <input type="checkbox"/>
	<b>L<sub>AF90</sub></b>	Yes ✓	No <input type="checkbox"/>
	<b>L<sub>AFmax</sub></b>	Yes ✓	No <input type="checkbox"/>
	<b>Set to record L<sub>Leq</sub> in 1/3<sup>rd</sup> octaves</b>	Yes ✓	No <input type="checkbox"/>
	<b>At 15 minute intervals</b>	Yes ✓	No <input type="checkbox"/>
	<b>Set to nearest 15 minute period</b>	Yes ✓	No <input type="checkbox"/>
<b>Noise meter calibration date (dd/mm/yy)</b>			1 March 2010
<b>Noise meter calibrator calibration date (dd/mm/yy)</b>			1 March 2010
<b>Noise meter check calibrated</b>		Before ✓	After ✓
<b>Wind speed (m/s)</b>			2.3
<b>Wind direction (degrees)</b>			Southerly (180°)
<b>Set Up By:</b>	JOHN SMITH		Name (Block Letters)
	Acoustic Consultant		Position
			Signed







## APPENDIX VIII: TYPES OF IMPULSIVE NOISES

Impulsive noise is sound characterized by brief bursts of sound pressure at a level which is significantly higher than the background.

*NOTE The duration of a single impulsive sound is usually less than 1 s.*

The definitions as outlined in the following paragraphs are provided to assist with the identification of impulsive sound sources of different magnitudes (reference ISO 1996-1).

**Regular impulsive sound sources** impulsive sound sources that are neither highly impulsive nor high-energy impulsive sound sources.

*NOTE* This category includes sounds that are sometimes described as impulsive, but are not normally judged to be as intrusive as highly impulsive sounds.

**Highly impulsive sound sources** any source with highly impulsive characteristics and a high degree of intrusiveness.

**High-energy impulsive sound source** any explosive source, or sources with comparable characteristics and degree of intrusiveness.

## APPENDIX IX: NOISE CONTROL AND MITIGATION

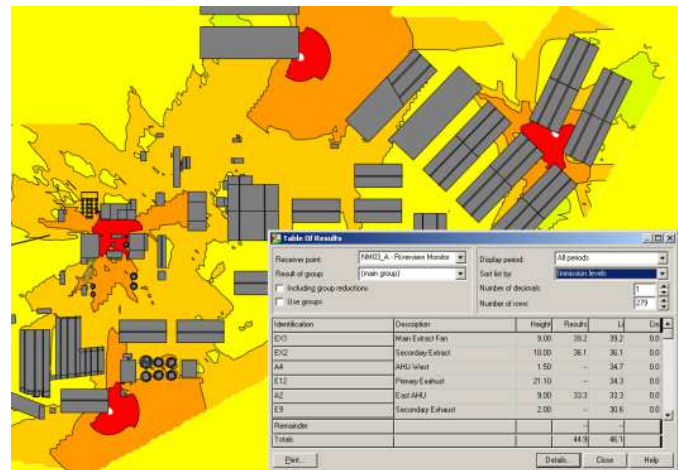
### Planning and Management of Noise Control

The issue of noise should come in for consideration as early as possible in the planning of a site. If potential noise impacts are identified early enough, it may be possible to address these by laying out the site in such a way as to use non-sensitive buildings to screen noisy items of plant from sensitive receptors. Failing this, the selection of quieter processes and equipment with inherently low noise output may obviate the requirement to employ proprietary noise control techniques.

If the impacts cannot be sufficiently ameliorated through careful zoning and equipment selection, it will be necessary to employ other forms of noise control. The comparison of calculated noise levels at noise sensitive receptors with the relevant limit values will confirm the extent of noise reduction that is required. Consideration may then be given to the optimum form of noise control, which may necessitate treatment to the source(s) of noise or the use of enclosures or barriers.

For larger sites and those with a lot of noise-generating plant, the use of a computer based noise model lends itself to a comprehensive analysis of noise propagation. It also aids the user in identifying the key contributors to off-site noise levels, thereby ensuring that noise control measures are correctly targeted. This applies equally to both proposed and existing sites.

Notwithstanding the need for comprehensive assessment and the application of proven noise control techniques, note that effective planning and management also calls for common sense and good practice. Some important points to bear in mind are set out below.



- Where feasible, noise should be controlled in the planning and/or implementation of activities. This can be achieved by altering site/plant layouts, suitable work practices and the selection of quiet plant and machinery;
- Where unavoidably noisy and/or directional plant is used, this should be positioned as far away from sensitive receptors as possible. Where possible, make use of site buildings to screen the source of noise;
- Group noisy items of plant together, perhaps reducing the noise control burden and/or reducing the number of locations where measures are required;
- When plant is due for replacement or modification, noise control should be a key issue and acoustical performance targets should be established for new equipment;
- Where potential noise issues are likely to arise, good acoustical design and practice at the outset should be encouraged;
- Where feasible, particularly noisy operations should not be permitted during night-time hours or in the early part of the morning in situations where an off-site impact is likely;
- Ensure that existing noise controls are effectively operated e.g. keep doors and windows to noisy process areas closed, ensure that cover-plates and acoustic hoods/enclosures are properly fitted and tightly sealed when plant is operating;
- Staff training and awareness may in some instances be the critical factors in maintaining control, e.g. by avoiding excessive revving of machinery, minimising impact noise and by switching off noisy equipment when not in use;

- Most machinery and equipment runs quieter when in good condition and properly adjusted. When poorly maintained, noise levels could be some 10 to 20dB  $L_{pA}$  higher. Poorly maintained noise control hardware does not function as well, and;
- Establish an ongoing and evolving programme of noise level measurement and noise control.

### Control of Noise at Source

The control of noise through treatment at its source is generally considered to be the preferred means of treating an existing noise source. This is good advice, provided the measures themselves are practicable and economic, insofar as a reduction at source reduces noise output in respect of all transfer paths and receivers. Measures for control of noise at source could take the form of actual physical changes, modification of processes or administrative controls.

**Impact Noise** typically arises from obvious sources such as hammer blows, however, it can also be a key component of noise output in less clear cut situations, e.g. gear noise, where teeth mesh and give rise to impulsive noise. Energy from impacts is produced over a wide frequency range and can therefore excite resonances in a wide variety of other components. If impacting surfaces can be 'cushioned', there is less energy involved and the frequency range is restricted (usually to the lower end of the spectrum). Impacts can be controlled by:

- substituting with quieter processes;
- reducing the force of the impact (e.g. change the shape of the surface(s) involved, provide softer surfaces, change machinery profiles/gearing), and;
- ensuring high maintenance standards.

The presence of any **Out-of-Balance Forces** in plant can lead to increased noise output. The degree to which such force may be present is typically a function of design, quality of construction or manufacture and/or maintenance level. Options for noise control in this instance are limited to replacement of the machine/process or ensuring good standards of quality control and maintenance.

**Stick-Slip Friction** occurs as a result of alternate sliding and sticking of two surfaces in contact, producing a 'ringing' effect. Lubrication, the obvious solution, may not be acceptable (e.g. brakes). Noise control options typically revolve around modification of points of contact, for example, changes to the angles of cutting tools or the leading edge in brake shoes. Noise control in this regard can often be an iterative process.

**Hydraulic Effects** are a function of the design of motors, pumps, valves and other components. A good design in terms of component reliability is often a good design from the noise perspective; this is because the forces involved are so great that sharp pressure pulses caused by sudden valve cut-off or by flow oscillations are not only noisy but also destructive. Likewise, designs that limit vibration also tend to limit noise.

There are two types of **Aerodynamic Noise**. Firstly, noise that is purely aerodynamic, where high speed jets mix with low speed air surrounding them, producing noise, e.g. a pneumatic valve or airline. The second type arises as a result of the interaction of airflow and a solid surface, e.g. fan blades, aircraft wings. The latter is by far the most common and can be minimised through good design – minimisation of turbulence and creation of smooth patterns of airflow.



Airline Silencer



When noise from any given source is transmitted into surrounding components by mechanical means, these components may emit sound, giving rise to what is known **Re-Radiated Noise**. This may be controlled by application of a damping material or use of materials with inherently greater damping properties. It can also be controlled by stiffening components or otherwise amending characteristics.

The importance of **Improved Design and Better Engineering** cannot be overstated. Manufacturers can play a part, by offering products with features that serve to reduce noise output or offering bespoke solutions for individual situations. Effective noise control of this type often goes hand in hand with improvements in efficiency.

### Controlling Noise Propagation

The control of noise propagation involves placing something in the transmission path between the source and the receiver in order to attenuate the noise. There are various techniques for doing this.

**Acoustic Enclosures** are sound insulating structures designed for significant containment or exclusion of sound. They may make use of acoustically absorptive lining to further reduce the build-up of noise inside the enclosure. These types of enclosure are typically semi-permanent and may be formed using demountable panels for easy access. Careful attention is required in respect of penetrations, ventilation and access.

Acoustic Enclosure



Acoustic Doorset

Access to plant rooms, production areas and other noisy spaces may be provided using **Acoustic Doorsets** in order to limit noise break-out. Such doorsets comprise an integrated assembly complete with frame, heavy doors and acoustic seals around the perimeter.

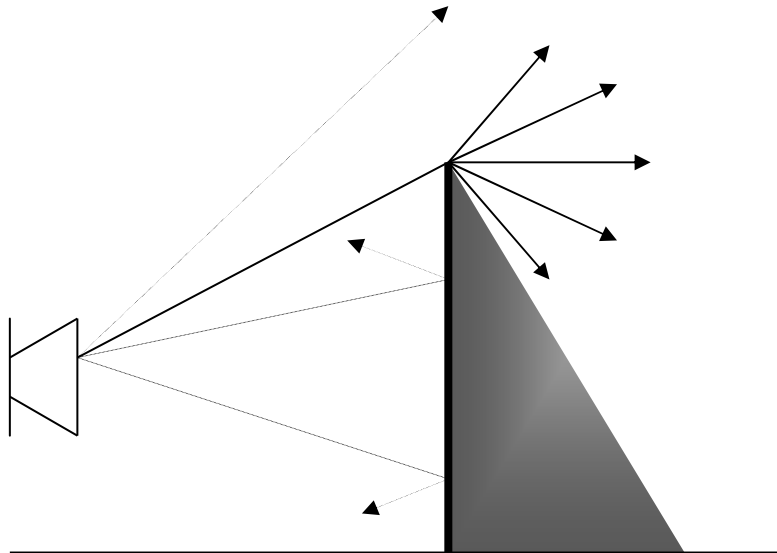
**Acoustic Lagging** is used to control noise break-out from items of plant such as fan boxes, also pipes and ductwork. Optimum performance is achieved using sandwich materials containing both absorptive layers and a mass barrier.



Acoustic Lagging on Ductwork



A **Noise Barrier** is a solid screen (or partial enclosure) placed between the source of noise and the receiver location. This creates a “shadow zone” in which the amount of sound reaching the receiver from the source is reduced. The amount of noise reduction is a function of the additional distance that the noise is forced to travel; hence the key factors dictating the performance of the barrier are its height and its distance from both the source and receiver, although it must also have sufficient mass to prevent noise travelling straight through.

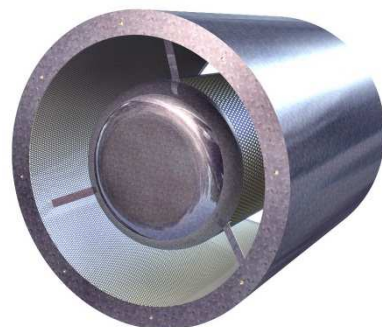
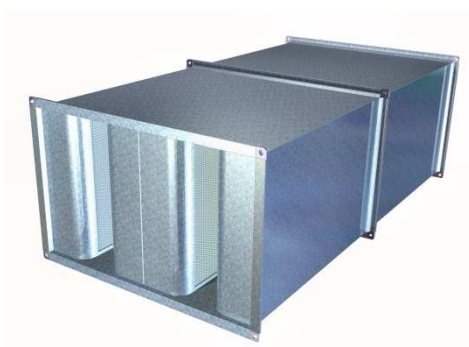


Barriers can take many forms, including proprietary timber constructions, masonry walls and semi-permanent demountable screens.

**Attenuators** are used to control noise transfer along ducts, noise egress from plant exhausts and break-out from plant rooms; they provide a means of reducing noise transfer whilst still permitting steady flow of air. There are various types, some of which are outlined below.

- *Dissipative* attenuators direct the flow of air through passages lined either side with an acoustically absorptive material. The most common variant is the rectangular splitter attenuator, in which the absorption is typically provided by mineral wool behind a perforated metal facing.

Rectangular Splitter Attenuator



Cylindrical Attenuator with Pod

- *Cylindrical* attenuators operate on similar principles to rectangular attenuators. They offer lower airflow resistance than rectangular attenuators although they typically provide less sound reduction than rectangular attenuators of the same length. Performance can be increased by the inclusion of an absorptive module in the centre of the airway, known as a “pod”.

- *Reactive* attenuators rely on a “tuned” element to significantly reduce noise transfer over a limited frequency range and as such are primarily of use in respect of fixed speed machinery emitting noise with a highly tonal content. They may be used in conjunction with dissipative attenuators to offer good overall performance.
- The application of an *absorptive lining* to ductwork (particularly on bends) and plenum chambers can attenuate sound by dissipative means. The lining typically comprises 25 to 50mm of foam or faced mineral wool. This approach is not as effective as employing a proprietary attenuator.

Absorptive Duct Lining



Acoustic Louvres

- *Acoustic Louvres* are effectively a combination of a normal louvre and a dissipative attenuator. They are typically used to provide free ventilation for internal plant rooms and to screen external plant items, particularly at rooftop level. An acoustic louvre is in effect a short attenuator with a large cross-sectional area, hence performance is limited. Additional performance can be obtained by placing two louvres back to back, a configuration known as ‘double bank’.

**Damping** refers to the reduction of motion in an oscillating system, e.g. a vibrating membrane that is giving rise to high levels of re-radiated noise. The provision of additional damping may reduce noise output; such damping could take the form of an applied compound, sheet materials or a constrained layers.



Spring Vibration Isolators

**Vibration Isolation** describes the use of resilient materials and products to reduce the transfer of vibration from plant items and associated equipment. Effective vibration isolation can also reduce noise emissions, although the benefits and the approach will vary from case to case. Factors determining isolator selection include loads presented, forcing frequencies and physical constraints.

## APPENDIX X: NOISE COMPLAINT INVESTIGATION FORMS

Site Details	
Site Name	
Licence Reg. No.	

Recording of a Complaint	
Date and time of complaint	
Assign reference number to complaint	
Complainant's name, address and contact details	
Class of noise complaint (i.e. residential, commercial, industrial or other)	
Has the person complained about the noise before (Yes or No)	
Complainant's description of noise source (e.g. vehicle noise, building services plant, voices etc.)	
Description of frequency and time periods of noise source (i.e. continuous, intermittent, day or night-time)	

Complaint Investigation	
Investigation carried out by	
Position	
Date and time	
Does the investigation period correspond to that of the complaint (Yes or No)	
Describe assessment location, sketch map where appropriate	
Does the assessment location correspond to the location of the complaint (Yes or No)	
Note meteorological conditions (approximate wind speed, direction, precipitation, cloud cover and temperature)	
Describe overall noise climate, note all primary contributors to noise build up	
Period of observation (should be a minimum of 5 minutes at each location)	
Volume descriptor for source of noise complaint (0 = not audible, 1 = barely audible, 2 = easily noticeable, 3 = loud)	
Characteristics of noise source in question (e.g. continuous, intermittent, potentially tonal or impulsive characteristics etc.)	
Subjective impression of noise source in question	
Summary of conclusion reached	
Is additional investigation and/or noise monitoring required (Yes or No)	
Should additional advice be sought from appropriate expert (Yes or No)	

Reporting and Correspondence	
Date of response	
Response method (e.g. letter, telephone, email, home visit etc.)	
Response reference	
Summary of response	
Additional actions	
Additional correspondence	

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