Guidance Note For Noise In Relation To Scheduled Activities

2nd Edition

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Preface

The objective of this guidance note is to provide practical information, advice and guidance on noise from activities licensable by the Environmental Protection Agency (EPA) under the Integrated Pollution Prevention Control (IPPC) and waste licensing systems.

The original "Guidance Note For Noise in Relation to Scheduled Activities", published by the EPA in 1995, provided general acoustic guidance for activities licensed by the EPA under the Integrated Pollution Control (IPC) licensing system (i.e. activities listed in the First Schedule to the Environmental Protection Agency Act 1992). The guidance has been updated and expanded in this second edition to reflect developments in legislation, licensing requirements and EPA policy since 1995 and to include additional guidance for waste activities (e.g. landfills and transfer stations) listed in the Third and Fourth Schedules to the Waste Management Acts 1996 to 2003.

The guidance note sets out some of the basic concepts of noise, vibration and best available techniques (BAT). Procedures used in the identification of tonal and impulsive noise are addressed and information is provided on rating levels, which take into account audible tonal and/or impulsive elements within the noise emissions from an activity. It is of note that the rating level recommended by the EPA incorporates the addition of a 5 decibel penalty to the specific noise level from an activity if the noise contains clearly audible tonal and/or impulsive elements.

Guidance is provided on a variety of practical techniques and measures to control noise. Issues such as the measurement and assessment of low frequency noise, the handling of noise complaints, the Environmental Noise Directive and factors to consider in developing a noise management programme are also addressed.

This document should be read in conjunction with the Environmental Noise Survey Guidance Document, published by the EPA in 2003.

The Guidance Note should not be considered as a legal document, nor does it purport to provide comprehensive legal advice or guidance on all acoustical matters. In many situations it may be necessary to seek expert advice and assistance.

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1. Introduction

Sound is a physical disturbance in a medium that is capable of being detected by the human ear. The medium in which the sound waves travel must have mass and elasticity. Sound waves will not travel through a vacuum.

Under the Environmental Protection Agency Act of 1992, 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 (POE) Act 2003 likewise includes noise in the definition of environmental pollution, which encompasses the 'introduction to an environmental medium, as a result of human activity, of … noise which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment'.

Noise has been defined as any sound which has the potential to cause disturbance, discomfort or psychological stress to a subject exposed to it, or any sound which has the potential to cause actual physiological harm to a subject exposed to it or physical damage to any structure exposed to it.

Noise is almost ubiquitous in the modern world and many normal everyday activities lead to the production and emission of noise. In most cases the majority of people scarcely notice these noises, and are not bothered by them, but in some cases people can be disturbed and/or annoyed by noise. Such people may find themselves in particularly noisy situations, or they may be annoyed by noise because they want to sleep or relax in a quiet atmosphere, or they may be more sensitive to noise than others.

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

Noise (and sound) is usually measured on the decibel scale, which is a logarithmic scale, based on a ratio to a reference level (20 micropascals). The sound pressure level (Lp) in decibels, corresponding to a sound pressure, p, is defined by:

$$Lp = 10 \log_{10} (p/p_0)^2 = 20 \log_{10} (p/p_0)$$

Where p_0 is the reference sound pressure of 20 micropascals (μPa).

The human ear is not equally sensitive at all frequencies. Thus, strictly speaking, sound pressure level is not a measure of the loudness of a sound. In order to obtain a measurement result that bears a closer relationship to the perception of loudness, a frequency weighting is incorporated into the result.

In an attempt to approximate the likely human response to a sound, we generally use the A-weighting network, in accordance with international standards. The A-weighted readings correspond most closely to the response of the human ear.

The units of the A-weighted decibel scale are abbreviated to dB(A), however the term 'sound level' generally implies that A-weighting has been used, unless otherwise stated.

The Table below describes how sound levels in certain environments might be perceived.

Sound level in decibels dB(A)	Description
0	Absolute silence
25	Very quiet room
35	Rural night-time setting with no wind
55	Day-time, busy roadway 0.5 km away
70	Busy restaurant
85	Very busy pub, voice has to be raised to be heard
100	Disco or rock concert
120	Uncomfortably loud, conversation impossible
140	Noise causes pain in ears

In order that noise emissions do not give rise to significant environmental impacts (e.g. cause annoyance to people), controls may be needed to reduce or eliminate certain noises.

The licences issued by the EPA for scheduled activities specified in the First Schedule to the Environmental Protection Agency Acts 1992 and 2003 (i.e. IPPC activities) and the Third and Fourth Schedules to the Waste Management Acts 1996 to 2003 (e.g. landfills, transfer stations and material recovery facilities) may have conditions attached to control noise. These conditions may include emission limit values for noise emissions that must not be exceeded. When limits are being established for noise emissions from such activities, regard is had to a wide range of factors, the most important of which are addressed in this document.

The assessment of noise and the determination of appropriate limits may sometimes require an assessor to reconcile the need for infrastructure and industry and the conflicting imperative to minimise noise. For this reason the judgement of the assessor may be pivotal and the facility operator may require expert advice and assistance.

Whenever necessary, expert advice, technical assistance and acoustical guidance should be sought from appropriately qualified and competent persons and/or members of professional bodies. It is important that the person or firm consulted can demonstrate an adequate degree of competence in acoustical matters.

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

- good comprehension and experience of relevant acoustical standards, e.g., ISO 1996 and BS 4142;
- 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_{A1}, L_{A10}, L_{A90}, L_{Amax}, L_{Aeq}, and $L_{Ar,T}$;
- 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 and predictions, where appropriate; and
- an ability to recognise when more specialised expertise may be needed.

A competent person needs to demonstrate both practical and theoretical competence and should participate in continual professional development.

2. 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. The Directive's provisions were transposed into national law by the Protection of the Environment Act 2003.

While the Environmental Protection Agency Act 1992 and the Waste Management Act 1996 required the use of BATNEEC (Best Available Technology Not Entailing Excessive Costs) to prevent, eliminate, limit, or abate emissions etc., the Protection of the Environment Act 2003 now requires the use of best available techniques (BAT).

2.1 Best Available Techniques (BAT)

BAT is defined in Section 7 of the Protection of the Environment Act 2003 as:

' …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.'

'Available techniques' are those developed on a scale which allows their implementation under economically and technically viable conditions, taking into consideration the costs and advantages. The concept of BAT requires a degree of balance between the attainment of environmental benefits and the likely cost implications for the facility operator. In the identification of BAT, regard should be had to a wide range of factors, including the design, management, maintenance and operation of an activity. Emphasis should be given to 'practical suitability' and the need 'to reduce an emission and its impact on the environment as a whole'.

Generally a determination of BAT will involve a comparison of the techniques that prevent or reduce emissions and an identification of the best techniques in terms of those that 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. 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 published by the Agency 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 management and IPPC activities. All operators should therefore continue to keep up to date with the best available technologies relevant to their activities.

At the operational and site-specific level the most appropriate techniques will depend on local factors. A local assessment of the advantages and the economic and technical viability 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.

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. The facility operator should aim for continuous improvement in performance to prevent, eliminate and/or progressively reduce noise emissions.

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 review is being processed.

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

- the nature, extent and effect of the emission concerned;
- the nature and age of the existing facility connected with the activity and the period during which the facility is 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 taken of sensitive receptors and local environmental impacts and a risk-based approach should be adopted to establish the extent of any noise impact and to identify appropriate controls.

3. Noise Criteria

3.1 Pertinent Factors in Determining Noise Controls and Limits

The primary objective of this Guidance Note is to provide some practical information and advice on noise for those activities that are listed in the First Schedule to the Environmental Protection Agency Acts 1992 and 2003 and the Third and Fourth Schedules to the Waste Management Acts 1996 to 2003 (refer to Appendix II). 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 (EQSs) which are designed to limit the concentration of pollutants in specified environmental media to a definitive quantitative level. Noise is unlike many 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 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 level;
- the nature and character of the locality; and
- the presence of special acoustic characteristics such as tones and 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 levels.

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 there is a small but significant minority which is more sensitive than others (Refer to Appendix VI).

The application of controls and limits should seek to minimise the amount of noise to which people in noise sensitive locations are exposed. Examples of such locations include domestic dwellings, hospitals, schools, places of worship and areas of high amenity. A more complete definition of the term 'noise sensitive location' (NSL) is given in Appendix I of this document.

3.2 Rating Levels for Tonal and Impulsive Noise

Some noise sources and industrial activities are inherently likely to give rise to tonal and/or impulsive noise. While it is important to ensure that this tonal and/or impulsive noise does not cause disturbance or annoyance, it is sometimes not practical to completely eliminate this type of noise.

A tonal or 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 tonal and impulsive noise in such cases may be problematic.

ISO 1996-2 (1987) and BS 4142 (1997) make reference to a '*rating level'* which takes account of tonal and impulsive elements in the noise spectrum. The rating level (L_{ArT}) is calculated by adding a penalty to the measured equivalent continuous A-weighted sound pressure level (L_{Aeq}). The purpose of the rating level is to arrive at a better estimate of the potential community response to the measured noise.

With regard to tones, ISO 1996-2 (1987) provides that if the level in one 1/3rd octave band is 5 dB (or more) higher than the level in the two adjacent bands, then there is the potential for the sound to be penalised by the addition of 5 – 6 dB, if the tonal components are clearly audible. This concept of a penalty recognises the fact that a tonal noise has the potential to be more annoying than a broad-band noise.

Normally an impulsive characteristic is determined subjectively as it should be clearly audible. While ISO 1996-2 (1987) and ISO 9612 (1997) describe objective methods for determining the existence of an impulsive characteristic, there is currently no methodology which unequivocally defines impulsive sound nor is there a universally accepted procedure for rating the additional annoyance of impulsive sound. Nonetheless, a rating level based on a penalty for clearly audible tonal and/or impulsive noise is currently advocated.

It is noteworthy that the Agency's preferred rating methodology is broadly in line with the BS 4142 (1997) assessment procedure in which a noise containing both impulsive and tonal characteristics is penalised by 5 dB. A 5 dB penalty also applies in situations where the noise is either tonal or impulsive.

In order for a tone or impulsive element to warrant a penalty it should be clearly noticeable and audible. Situations in which a 5 dB penalty should apply include the following:

- the noise contains a distinguishable, discrete continuous note (whine, hiss, screech, hum etc.);
- the noise contains distinct impulses (bangs, clicks, clatters, or thumps);
- the noise is irregular enough to attract attention;
- the level in one 1/3rd octave band is 5 dB (or more) higher than the level in the two adjacent bands and the tonal components are clearly audible.

In the vast majority of cases a tonal or impulsive noise will be noticeable and obvious and thus the decision to penalise is straightforward. If a doubt or dispute arises about the presence of a tonal noise, then the provisions of ISO 1996-2 (1987) should be used in the assessment, i.e. tonal presence can be detected by 1/3 octave analysis or by narrow-band analysis. A real-time sound level analyser (i.e. one which incorporates parallel processing) permits the measurement of a number of bands simultaneously and thus allows direct comparisons between the measured levels. This is more preferable than using an analyser which utilises sequential continuous filters.

If a doubt or dispute arises about the presence of an impulsive noise, then an objective and approved assessment technique must be used (with the onus on the assessor to justify the use of a particular methodology). Assessment techniques may involve a direct comparison of the $L_{A F, max}$ and the $L_{Aeq, T}$ and, where there is a difference of 10 dB or more, this could indicate an impulsive characteristic. Alternatively the provisions of ISO 1996-2 (1987) can be used in the assessment. This latter method involves measuring the difference between the A-weighted sound pressure level, determined with time-weighting characteristic I, averaged over the same time interval, and $L_{Aeq,T}$. A value of greater than 2 dB (i.e., where $L_{AIeq,\,T}$ - $L_{Aeq,\,T}$ = 2 or > 2) would indicate an impulsive characteristic (ISO 9612, 1997).

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

3.3 General Guidance and Limits for Licensed Facilities

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 to on-site activities should not generally exceed a free-field $L_{Ar,T}$ value of 55 dB by daytime (08:00 – 22:00), at any noise sensitive location. During night-time (22:00 – 08:00), the noise attributable to on-site activities should not exceed a free-field $L_{Aeq,\,T}$ value of 45 dB.

Rigorous efforts should be made to avoid clearly audible tones and impulsive noise at all sensitive locations, particularly at night-time. A penalty of 5 dB for tonal and/or impulsive elements should be applied to the day-time measured L_{Aeq} values in accordance with Section 3.2 of this guidance, to determine the appropriate rating level ($L_{Ar,T}$). In all cases, a subjective assessment by a competent and qualified person will be required to determine the rating level and an explanation and/or justification of the rating will be required. During night time no tonal or impulsive noise from the facility should be audible at any noise sensitive location.

In addition to the foregoing criteria and limits, the noise from the licensed facility should 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 and qualified person will be required.

In particularly quiet areas, such as remote or rural settings, where the background noise levels are very low (e.g., below approximately 35 dB measured as L_{90}), lower noise limits may be more appropriate and this may be reflected in more stringent licence limits. Reference should be made to the 2003 report published by the Agency – 'Environmental Quality Objectives - Noise in Quiet Areas' (2000-MS-14-M1). Pertinent policy decisions or legislative developments that arise in relation to Quiet Areas may also have implications for remote facilities.

3.4 Setting Limits on Noise Emissions

This entails setting numerical noise limits which are not to be exceeded. These limits may apply to individual sources of noise on-site, at the site boundary of the plant, or at the nearest noise sensitive location(s). 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 of a facility.

Higher limit values may be set at the boundary than at noise sensitive locations to reflect the relative proximity to the source of noise. 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 noise sensitive locations and receptors for 'one off' developments, and particularly for green field sites.

Alternatively, noise limits may be set on individual sources of noise, taking cognisance of the target limit levels to be achieved either at the boundary or nearest noise sensitive location. This approach would normally only be considered if there were difficulties in attaining reliable noise data at the site boundary or at noise sensitive locations. 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 noise sensitive locations. Facility operators should therefore be aware of any future planning in the vicinity of their facility.

3.5 Assessing Compliance with Criteria and Limits

A periodic noise assessment will normally be required at a licensed facility and the nature and scope of the assessment should be determined by the site-specific conditions and operational history. The Agency will normally require a licensee to undertake a more extensive assessment in situations where there has been a history of noise complaints. Specific guidance on complaint investigation is presented in Appendix V of this document. Other factors that will influence the nature and scope of the assessment include:

- the location, proximity and sensitivity of NSLs and receptors;
- the likelihood of noise emissions causing annoyance and/or disturbance;
- the nature and character of the locality and the ambient noise in the absence of noise from the specific facility;
- the presence or absence of topographical features and/or buildings or other structures which may help to attenuate noise emissions;
- the characteristics of the noise sources at the facility, e.g., is the noise typically broad-band, tonal and/or impulsive;
- the normal operating times of noise sources at the facility and any possible variations or irregular emissions; and
- the type of noise mitigation measures adopted at the facility and their success.

In assessing compliance, the noise measurements should normally be carried out at least 3.5 metres from any reflecting structure other than the ground (i.e., free field conditions). The preferred position for the microphone is 1.2 to 1.5 metres above ground level.

Appropriate and representative sampling intervals should be selected and justified. Normally, the typical intervals or ‘averaging times’ will be 15 – 30 minutes during daytime, and 5 – 15 minutes during night-time. These may need to be supplemented with shorter or longer sampling intervals in certain situations. Regard should be had to any time intervals specified in the appropriate licence and to worst case noise scenarios at the facility.

The time intervals used may need to be adapted to site-specific conditions (e.g., cycles of noise emissions at a plant). Any deviations from the typical measurement time intervals will need to be justified. At some sites, where the L_{Aeq} is mainly influenced by extraneous noise such as road traffic, a 30 minute sample may be excessive. Pertinent and critical data can often be gathered by using a series of short-term sampling intervals (especially when sources operate at a steady level) to try to exclude the influence of extraneous sources. Alternatively, specialist acoustic software may be used to extrapolate and interpret the monitoring results.

Monitoring for compliance should generally be based upon International Standard ISO 1996 (with a rating penalty for tones applied as per Section 3.2 above). Otherwise the assessor may use BS 4142 to undertake the assessment, particularly for rating the noise and/or when the impact relative to background noise is being assessed. This monitoring may be supplemented with additional assessment methodologies as deemed appropriate by a qualified and competent assessor. In all cases, regard must be had to provisions of the Agency's 2003 Environmental Noise Survey Guidance Document.

Noise measurements taken when weather conditions may have introduced unacceptable errors into the data should be identified and eliminated, where possible. Such weather conditions include rainfall, and wind-speeds in excess of 7 metres per second (m/s). An average wind speed of less than 5 m/s is the preferred limit when measurements are being taken.

It is good practice to refer to local meteorological records and to log wind speed and direction measurements on site during a noise survey. In all cases, care should be taken to avoid measurements being made so close to objects as to give rise to wind derived noises, e.g. trees, pylons, cables, buildings, etc.

In some cases, certification for compliance with noise limits by direct measurement may present special difficulties. In these circumstances computer prediction methods using input data of sound power levels from components of the plant (taken by direct measurement) may be acceptable. Alternatively sound pressure level measurements at specified reference positions may be extrapolated or used to estimate impact levels at receptor positions. The details of any prediction programme to be used should always be agreed with the Agency.

For compliance, the long term mean value of the criterion noise level should not be exceeded. Occasional exceedances of up to 2 dB may be acceptable, provided that this is allowed by the licence issued for the facility. The noise from all activities should be controlled so that it is not so loud, so continuous, so repeated, of such duration or pitch and occurring at such times as to give reasonable grounds for annoyance. There is no relaxation on the requirement that all licensed facilities should be compelled to use BAT to eliminate and control tonal and impulsive components and to reduce the noise impact to as low as is reasonably practicable. Further guidance on noise control and mitigation measures is provided in Sections 4 to 7.

With regard to BAT, the operator should always utilise good practice and adopt a precautionary approach to noise control. Even when apparent problems do not arise, efforts should be made to prevent creeping ambient noise levels and to reduce the overall noise impact whenever possible. Compliance with noise limit values alone is not sufficient and BAT for noise and vibration needs to be assessed on a site specific basis.

4. Noise Control and Mitigation Measures

4.1 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 layout, 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 on the performance of certain equipment or may result in reduced energy efficiency).

While the identification and application of mitigation measures is generally considered during the planning or environmental impact assessment stage of a project, the management and control of noise will require the implementation of mitigation measures for the lifespan of the activity (including the decommissioning phase).

At some facilities a combination of factors (e.g. inherently quiet plant and/or effective containment of noise 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, based on a risk assessment approach, be adopted for most facilities. Some of the factors addressed in Section 3.1 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.

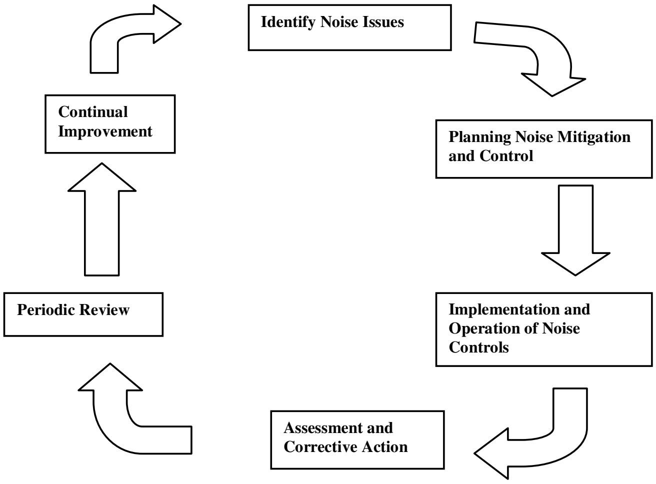
The majority of facilities can be categorised as either Low Risk or High Risk with regard to noise and an indication of some of the pertinent considerations is presented in a schematic in Appendix IV. This schematic should be used to assist licensees and enforcement officers to assess the level of risk, rather than serve as a rigid tool for classifying each facility.

Many facilities will require some form of Noise Management Programme and only in exceptional cases will a dedicated programme not be necessary. These circumstances will include facilities where:

1. the noise level attributable to the facility always complies with the relevant noise limits, the rating level ($L_{Ar\ T}$) is less than 55 dB during daytime and the L_{Aeq} is less than 45 dB at night time at the facility boundary;
2. the rating level attributable to the facility is no more than 5 dB higher than the background noise (measured as an $L_{A,\ 90}$ level in the absence of noise from the facility);
3. the noise is broadband, i.e. there is a complete absence of tonal and impulsive noise as determined by subjective and objective assessments, at the facility boundary; and
4. there is no history of justifiable noise complaint and sensitive receptors are remote or well screened from dominant noise sources.

Unless all of the foregoing factors are applicable, it should be 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.

A Noise Management Programme can be defined as that part of the overall management system that addresses the environmental noise issues associated with 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.



The priorities for the Noise Management Programme should be a clear identification of the pertinent environmental noise issues relevant to the facility, the planning and implementation of noise controls, assessment and corrective action, and periodic review.

As stated previously a risk assessment based approach should be adopted with regard to the necessity for a formal Noise Management Programme at every facility. However, even low risk facilities will need to have ongoing regard to their noise emissions as part of an integrated approach to pollution prevention and control. In this regard it is noteworthy that in some instances the installation of new emission control equipment, such as atmospheric abatement equipment, may significantly increase noise emissions.

Other situations that pose potential problems for facility operators may include the establishment of new residential property and/or other noise sensitive locations in close proximity to a pre-existing facility, or changes in background noise levels due to extraneous factors.

4.2 Options for Noise Mitigation and Control

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. While there is an obvious overlap between some of these, examples of good practice and potential control approaches are given in the following sections.

4.2.1 Planning and Management of Noise Control

An awareness of the key environmental noise issues (dominant sources, noisy production processes etc. and their impact on noise sensitive locations) should be developed. At each facility it is important to adopt a logical and systematic approach to noise management. The first step for an existing facility is the assessment of any existing or planned noise sources and their relative contribution to ambient levels.

The next step is the establishment of target noise levels for the particular situation or source. The degree of noise reduction required can then be estimated. Having established the noise reduction required, the next stage is the application of noise control engineering principles.

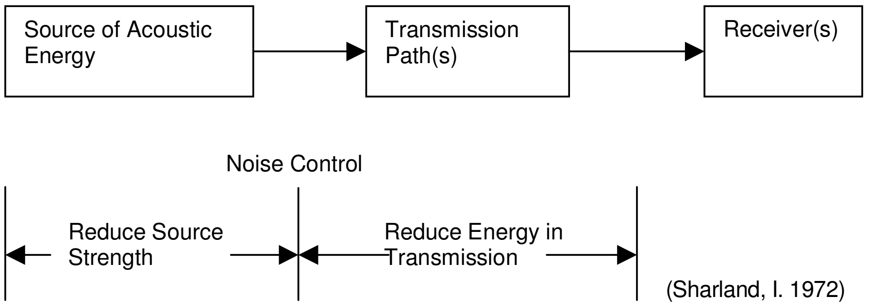
The final solution for a noise problem may involve more than one noise control measure (e.g. absorption as well as screening, or isolation as well as damping). Effective planning and management may also involve the use of common sense and good practice rather than high-tech engineering solutions. Some important management/control options include:

- where feasible, noise should be prevented at source in the planning and/or implementation of activities. This can be achieved by 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 from sensitive receptors as possible;
- when certain plant is due for replacement or modification, noise control should be a key issue and acoustical performance targets should be set 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 run 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. where practicable doors and windows to noisy process areas should be closed when plant is operating, and cover-plates and acoustic hoods/enclosures should be properly fitted and tightly sealed;
- 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;
- regular, proactive maintenance of machinery and plant with particular attention to dedicated noise control equipment; and
- frequent noise surveys and assessments by competent personnel.

4.2.2 Controlling Noise at Source

Controlling noise at source is by far the most desirable form of mitigation, however it can be economically prohibitive and technically demanding. For each significant or problematical noise source, a detailed examination of all the noise generating mechanisms is required. In addition an assessment of how noise is radiated by a particular machine or process is necessary.

Most noise control problems can be represented by a simple energy flow diagram. This generally gives rise to two main options of control, i.e. to reduce the source strength or to impede the acoustic energy along its transmission path. The mechanisms by which a sound is generated and the exact part of the machinery/equipment responsible will largely dictate the treatment options.



(Sharland, I. 1972)

Noise, with the exception of aerodynamic noise, is generally caused by a force causing a surface to vibrate. Surfaces or panels radiate sound most efficiently at or near any of their modal or resonant frequencies and some control measures involve the application of coatings or damping layers or mechanical stiffening devices which subdivide the panel so that the modal frequencies move upwards and become less problematical.

While noise control engineering is a specialist subject, in many situations the objective is to decouple the mechanical path between the source of vibration and the radiating surface. There is a wide range of noise control techniques, however they can be loosely categorised as follows:

- control of resonances – e.g. altering the mass and/or stiffness of the panel or changing the running speed of a machine to detune it from the natural frequency of the panel;
- control of stiffness – e.g. the use of resilient layers/treatments;
- vibration isolation – e.g. the use of isolating springs to reduce the transmission of vibration to building structures or to larger machines or machine parts; and
- increase in damping – a process whereby vibrational energy is converted into heat through some form of frictional mechanism (e.g. constrained or unconstrained layer damping techniques).

Many noise sources such as industrial machinery have a fixed design which may be difficult to modify without reducing performance or efficiency, however noise is frequently caused by the turbulent flow of gases and fluids and these types of noise sources can be modified to reduce their noise output. Common examples of these include exhausts and blow-offs of air or steam which cause jet noise, and turbulence caused by control valves in pipelines. In most systems the noise emission is directly proportional to the degree of turbulence and therefore many control techniques aim to reduce the velocity and pressure of the fluids and smooth out the flow.

4.2.2.1 Jet and Valve Noise

There are two fundamental methods of controlling jet noise, (i) reducing the jet velocity and (ii) providing local absorption around the noise source. Effective control of pressure relief and dump systems can be achieved by the use of jet noise mufflers or vent silencers which consist of a shroud with an acoustically absorbitive lining.

Steam jets in particular are amenable to having their efflux velocity reduced by water injection, i.e. cold water is mixed with high temperature steam just before the jet efflux and for a given mass flow this means a reduction in jet velocity.

Valve noise generally becomes important when gas flows and valve settings are in a combination that produces supersonic flow through the orifice. Where high pressures are unavoidable, the aim should be to reduce them as progressively as possible rather than in one step and this can be achieved by the use of a number of valves in series. In addition, low noise valves are commercially available and these contain a filter or porous material (e.g. sintered metal) through which all the gas must pass. The effect of this is to slow the high velocity jet progressively so that the region of high shear gradients (characteristic of a single jet) are not allowed to develop.

4.2.2.2 Fan and Ducting/Pipeline Noise

Some external ducting, pipelines and air/gas lines are lagged in an attempt to reduce noise. While a variety of lagging types are used for the purpose of thermal insulation, many of these are unsuitable for acoustic insulation. One of the fundamental requirements of acoustic insulation is that a heavy damped impervious outer layer should be fitted over a vibration isolating layer wrapped around the pipe. The vibration isolating layer may be constructed of an un-bonded fibrous material such as mineral or glass wool, capable of supporting the weight of the outer layer.

Noise from high level or roof-mounted fans can give rise to significant noise emissions, which may be tonal. For this reason particular emphasis should be given to the design and installation of fans. Critical issues in this regard include: the fan speed; the blade pass frequency; and the number of fan blades. In addition, the use of anti-vibration mountings and resiliently mounted duct work can be essential. Care should be taken to ensure that the chosen fan operates at or near its maximum aerodynamic efficiency, i.e. at the recommended static pressure for the volume flow rate required.

In some systems it may be necessary to fit in-line silencers upstream and/or downstream to minimise the radiation of fan noise through duct work. There are two different types of silencer, dissipative (or absorptive) silencers and reactive silencers, however both mechanisms may be used to achieve noise reduction.

The simplest type of absorptive silencer is a duct with its walls lined with sound absorbing material. Reactive silencers operate by changing the cross section of a pipe or duct and thereby producing a change in the acoustic impedance which causes sound energy to be reflected back towards the noise source. The amount of attenuation produced depends on the ratio of the cross sectional area in the expanded and original sections of pipe.

4.2.2.3 Preventative Maintenance

Noise complaints may arise due to the operator’s failure to notice defects such as worn bearings, loose drive belts, imbalances in machinery, or friction noise caused by inadequate lubrication. In addition, noise complaints may arise when acoustic attenuators (e.g. combustion engine silencers) are damaged and/or blown or when acoustic seals or enclosures are defective or loose fitting. A preventative maintenance programme can be useful in the prompt identification of noise problems and may also reduce the potential for emergency downtimes.

4.2.3 Controlling Noise Propagation

In the simplest case, the positioning of a noisy sound source (e.g. a compressor) inside a plant room will in itself have the potential to significantly reduce the environmental noise emissions. This may have occupational exposure implications however. Good design and attention to detail must be employed when housing noisy equipment in order to ensure the effectiveness of the sound insulation, (e.g. poor standards of construction or holes in walls for services, and/or badly fitted doors or windows can result in the loss of insulation properties). Natural ventilation systems can significantly reduce the sound insulation properties of plant rooms and some situations will require the use of acoustic louvres and/or ventilation systems with in-line silencers.

Many forms of plant and equipment can be supplied with their own sound enclosure, however the design and construction of enclosures on-site in many cases is a straightforward matter. According to Sharland (1972) there are some critical guiding design rules:

- the walls (and ceiling) must provide an adequate sound reduction index;
- regard must be had to the effect of access panels, viewing ports etc.;
- maximum absorption at all frequencies of interest should be provided within the enclosure; and
- mechanical isolation between enclosure structure and the machine and any associated services (e.g. pipe work, ducting etc.) must be as complete as possible.

Many texts provide detailed guidance with regard to the design of enclosures (e.g., Sharland, I. 1972 and BS 5228) and a simple enclosure should be readily capable of reducing the A-Weighted Sound Pressure Level by 20 dB. In many instances however items of equipment (blowers, motors etc.) will require some form of ventilation to enable them to function efficiently. In addition, regard should be had to any occupational exposure issues that may arise as a result of the use of enclosures. As a form of compromise, sometimes a partial enclosure or an open-sided shed lined with absorbent material can be used effectively to achieve reductions of the order of 10 dB and higher, depending on factors such as the frequency of the sound.

Where enclosures are not suitable, an acoustic screen or barrier may be used, however care is needed in their design as in some instances the barrier may simply transfer a noise problem from one receiving position to another. For maximum performance, a barrier should be positioned as close as possible to either the noise source or the receiving position.

5. Quarrying and Mining Operations

At quarry sites the sequencing of site workings/activities should be such that the screening afforded by natural topography is maximised. Haul roads should, wherever possible, be sited so that they are screened by natural topography or stockpiled materials. In addition, road gradients should be minimised to avoid low gear/high revving of vehicles.

Low profile plant should be considered to reduce the overall height which will in turn aid the acoustic screening of the noise emissions. Efforts should be undertaken to minimise the height which material drops from lorries or other plant, and rubber linings may be used in chutes, dumpers, trucks and other transfer points to reduce the noise of falling rock upon metal surfaces. Other noise control techniques involve limiting the use of particular types of plant, limiting the number of items in use at any one time and maintaining equipment to ensure the integrity of silencers.

On many sites reversing alarms can cause disturbance at NSLs. The use of 'white noise alarms', units which adjust to the ambient noise, or directional modulated alarms can significantly reduce the off-site noise impact. While these may be evaluated on a case-by-case basis, regard must be had to any health and safety issues that may arise.

Many of the general noise control techniques referred to in Section 4 are applicable to quarries and mines, however traffic management can often be the cornerstone to good noise control.

Effective traffic management measures might include:

- minimising the number of vehicles/heavy plant that are active on site at any one time;
- ensuring regular maintenance of vehicles and periodically assessing sound levels attributable to each machine, e.g. by taking noise measurements at specified reference distances;
- ensuring that noisy vehicles are parked as far as possible from noise sensitive areas;
- maintaining road surfaces so as to minimise noise and vibration;
- switching off idling engines where possible and preventing excessive revving; and
- ensuring that drivers are aware of the potential for noise to cause annoyance or disturbance to local residents and that drivers show due regard upon entering and leaving the site (e.g. no unnecessary horn blowing).

Noise is liable to give rise to complaints whenever the noise level significantly exceeds the pre-existing level or whenever it exceeds the licensed limits. Given that quarries and mines are generally situated in remote locations, extra vigilance is required whenever noisy plant is operating close to the site boundary and/or NSLs (e.g., during the construction of embankments or haul roads).

Regard must be had at all times to the impact at NSLs and appropriate controls must be adopted. Minimising the early morning and late evening operational hours may be essential in many cases and the development of good communications with neighbouring residents is recommended.

Other pertinent noise management and control measures include:

- using buildings to contain noisy fixed plant and undertaking noisy activities indoors, where practicable;
- fitting silencing equipment (e.g. baffles, muffles) to plant and equipment, where practicable;
- using acoustic enclosures or screens around plant or equipment;
- ensuring, where practicable, that enclosures and doors/windows to noisy process areas are properly sealed or closed; and
- effectively recording and investigating all noise complaints.

5.1 Potential Blasting Impacts

At quarries or mines where blasting occurs once per week or less the vibration levels from blasting should not exceed a peak particle velocity (PPV) of 12 mm/s, measured in any three mutually orthogonal directions at a receiving location. For more frequent blasting the peak particle velocity should not exceed 8 mm/s. These levels are for low frequency vibration, i.e., less than 40 Hz. However, when the frequency of vibration is less than 10 Hz the peak particle velocity should not exceed 8 mm/s.

Human beings are known to be very sensitive to vibration, the threshold of perception being typically in the PPV range of 0.15 – 0.3 mm/s, at frequencies between 8 Hz and 80 Hz for continuous vibrations, and 0.5 – 1.5 mm/s in the case of impulsive vibrations from blasting operations. Vibration nuisance may be associated with the assumption that, if vibrations can be felt, then damage is inevitable; however, considerably greater levels of vibration are required to cause damage to buildings and structures.

Blasting should not generally give rise to air overpressure values at sensitive locations which are in excess of 125 dB $(Lin)_{max\ peak}$. The imposition of an absolute air overpressure limit can be impractical however, because of the effects of varied atmospheric conditions or minor changes in the blast design. The best type of regulatory control may be to include a specified limit, but to express this as a 90 – 95th percentile value of all monitoring results. This would permit some leeway for a small number of individual measurements.

Local residents and property owners in the vicinity of blasting operations may sometimes be concerned about the possibility of long term structural damage to their buildings. These concerns can be allayed to some extent if the operator has a good public relations policy and responds quickly and decisively to any complaints or queries received. In this respect, a well co-ordinated and regular blasting schedule, a proactive communications procedure, an open invitation to review all monitoring data on site, and a regular review of the blast design may be incorporated into the blasting procedures on site.

5.2 Minimising Blasting Impacts

Some good practice guidelines with regard to blasting are as follows:

- undertake adequate site reconnaissance and rock face surveys in advance of blast design;
- ensure that blast design incorporates appropriate safety margins;
- ensure appropriate burden to avoid over-confinement of charges;
- use correct charging and stemming to control air overpressure and vibration;

- minimise the maximum instantaneous charges (MICs), e.g. by the use of decked charges; and
- where practicable, avoid blasting in unfavourable weather conditions, e.g. temperature inversions or when there are moderate to strong breezes (Force 4 and higher) towards sensitive receptors.

Details on complaint investigations are presented in Appendix V. Further information on the control of noise emissions from quarrying and mining operations is provided in Minerals Policy Statement 2: Controlling and Mitigating the Environmental Effects of Minerals Extraction in England, ODPM, 2005 and Minerals Planning Guidance MPG11: The Control of Noise at Surface Mineral Workings, DoE/Welsh Office, April 1993. Useful guidance may also be found in BS 5228.

6. Landfill Operations

The activities carried out at landfills inevitably lead to the generation of noise. The main sources of noise at a typical landfill include vehicle and plant movements associated with the delivery of waste to the landfill, the deposition, compaction and covering of waste, the construction of new cells and the capping and restoration of filled cells. Typical vehicle and plant operating at a landfill include refuse collection vehicles, excavators and steel wheeled compactors. Specific activities or equipment on site can also contribute to localised noise emissions on an intermittent basis e.g., vehicle and wheel cleaning, lifting operations, generators etc.

Fixed plant, including landfill gas flares, engines and leachate extraction and treatment plant may also contribute to the noise environment at a landfill. Some of the fixed plant, e.g. the landfill gas flare, may have the potential to emit noise with a characteristic tonal component and consequently the plant should be situated in appropriate locations on site, e.g. in areas of the site remote from sensitive receptors.

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

On some landfill sites reversing alarms can cause disturbance at NSLs. The use of 'white noise alarms', units which adjust to the ambient noise, or directional modulated alarms can significantly reduce the off-site noise impact. While these may be evaluated on a case-by-case basis, regard must be had to any health and safety issues that may arise.

Many of the general noise control techniques referred to in Section 4 are applicable to landfill sites. In addition, traffic management plays an important role in the control of noise and some traffic management measures are reiterated below:

- minimising the number of vehicles/heavy plant that are active on site at any one time;
- ensuring regular maintenance of vehicles and periodically assessing sound levels attributable to each machine, e.g. by taking noise measurements at specified reference distances;
- ensuring that noisy vehicles are parked as far as possible from noise sensitive areas;
- maintaining road surfaces so as to minimise noise and vibration;
- switching off idling engines where possible and preventing excessive revving; and
- ensuring that drivers are aware of the potential for noise to cause annoyance or disturbance to local residents and that drivers show due regard upon entering and leaving the site (e.g. no unnecessary horn blowing).

Noise is liable to give rise to complaints whenever the level significantly exceeds the pre-existing level or whenever it exceeds the licensed limits. Given that landfills are sometimes located in remote locations, extra vigilance is required whenever noisy plant is operating close to the site boundary and/or NSLs.

Regard must be had at all times to the impact at NSLs and appropriate controls must be adopted. Curtailing the main noise generating activities during the early morning and late evening may be important in some cases and the development of good communications with neighbouring residents is often helpful.

Other pertinent noise management and control measures include:

- using buildings to contain noisy fixed plant and undertaking noisy activities indoors, where practicable;
- fitting silencing equipment (e.g. baffles, muffles) to plant and equipment, where practicable;
- using acoustic enclosures or screens around plant or equipment;
- implementing a regular maintenance programme for plant and equipment used on-site;
- employing bunds around waste deposition areas; and
- effectively recording and investigating all noise complaints.

Further information on noise emissions from landfills and the control of these emissions is provided in the Agency's guidance note 'BAT Guidance Notes For The Waste Sector: Landfill Activities' (Draft April 2003) and in the UK Environment Agency's Guidance for the regulation of Noise at Waste Management Facilities, Version 3, July 2002. Other useful references include the DoE/Welsh Office 1993 MPG11 publication and BS 5228.

7. Waste Transfer Stations, Materials Recovery Facilities and Waste Treatment Facilities

Noise is produced during the acceptance, handling and processing of waste at waste transfer stations, materials recovery facilities (MRFs) and waste treatment facilities and during the removal of wastes offsite. Noise may be generated through the movement of waste collection vehicles and skips, the deposition, loading and sorting of waste and the use of front loaders, excavators and grabs to move waste. Noise may also arise at these facilities from waste processing plant including shredders, trommels, compactors, picking lines and bailers and from emission control equipment such as negative air pressure systems.

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

Many of the general noise control techniques referred to in Sections 4 – 6, are applicable to transfer stations, MRFs and waste treatment facilities.

Some of the pertinent noise control measures include:

- undertaking noisy activities indoors, where practicable, or in areas of the site that are remote from NSLs;
- using acoustic enclosures / screens around plant or equipment or near noise sensitive locations;
- employing the traffic management measures outlined in Sections 5 and 6;
- minimising the operation of significant noise generating equipment or plant at night;
- implementing a regular maintenance programme for waste handling and processing plant and equipment;
- ensuring, where practicable, that enclosures or doors/windows in buildings are properly sealed or closed when noisy waste handling and processing equipment or plant is operating inside the enclosure or building; and
- effectively recording and investigating all noise complaints.

Further information on noise emissions from waste transfer stations, MRFs and waste treatment facilities and the control of these emissions is provided in the Agency's guidance notes 'BAT Guidance Notes For The Waste Sector: Transfer Activities' and 'BAT Guidance Notes For The Waste Sector: Waste Treatment Activities' (Draft April 2003). Pertinent guidance can also be found in the UK Environment Agency's Guidance for the regulation of Noise at Waste Management Facilities, Version 3, July 2002. Other useful references include the DoE/Welsh Office 1993 MPG11 publication and BS 5228.

8. The Environmental Noise Directive

The stated aim of the Environmental Noise Directive (END) (2002/49/EC) is to 'define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise'. This is to be achieved progressively by:

- determining exposure to environmental noise through noise mapping;
- making information available to the public; and
- adopting action plans by member states, based on the noise maps, to reduce environmental noise and to preserve environmental noise quality where it is good.

The Directive mainly addresses noise emitted by a range of transport sources (road, rail, and air traffic), although the definition of 'environmental noise' includes noise from industrial sites. The implementation of the Directive will involve the drawing up of strategic noise maps and the implementation of action plans to achieve a reduction in ambient noise levels. Noise reduction strategies may include traffic planning, land use planning, technical measures at noise sources, and regulatory or economic measures or incentives. Every action plan should contain an estimate of the number of people it would benefit, in terms of sleep disturbance, annoyance, or other factors. Strategic Noise Maps will initially be required by the 30 June 2007 for the following:

- Agglomerations with more than 250,000 inhabitants.
- Major roads with more than 6,000,000 vehicle passages/annum.
- Railways with more than 60,000 train passages/annum.
- Major airports with more than 50,000 takeoffs and landings per year.

The Directive describes certain 'selected common noise indicators' or indices and their application. The selected indicators are L_{den} to assess annoyance and L_{night} to assess sleep disturbance. These are A-Weighted long-term values which are defined in Annex I of the Directive (and also in the glossary of this Guidance Note) and are all a variation of the L_{Aeq} which has traditionally been used in licence conditions.

Each of the member states of the EU must implement the Directive and there are specified deadlines within which to comply with certain obligations. For example any limit values used to control noise from the relevant classes of noise sources as outlined above, must be communicated to the European Commission by the 18^{th} of July 2005. These limit values must be in terms of L_{den} and L_{night} and, where appropriate, L_{day} and $L_{evening}$ (refer to Glossary).

It is envisaged that licence conditions may eventually be framed in accordance with the 'selected common noise indicators'. While these terms are primarily intended to be ascribed to long-term noise levels, pertinent licence documentation (e.g. application forms, licence conditions and survey reports) may need to make reference to these indicators. While it is difficult at present to determine whether L_{den} would be useful in the regulation of IPPC and waste facilities, (it is an annual average and a parameter designed for strategic purposes) the implementation of the END may make its use compulsory. In situations where continuous environmental monitoring is undertaken, the assessment reports should include details of all relevant $L_{Aeq,}$ percentile and octave band analysis results. In addition, the results should be expressed in terms of L_{den} and L_{night} and, where appropriate, L_{day} and $L_{evening}$.

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Appendix I: Glossary of Terms

Air Overpressure
Whenever explosives are detonated airborne waves or air overpressure is invariably generated. These pressure waves will consist of energy over a wide range of frequencies, some of which are audible and are known as sound or noise waves, but most of which are at frequencies that are below the audible range (20 Hz) and are known as concussion. Air overpressure is expressed as dB (Lin).

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

Annoyance
Annoyance has been defined as a feeling of displeasure evoked by a noise or any feeling of resentment, displeasure, discomfort and irritation when a noise intrudes into someone's thoughts and moods or interferes with activity. It is important to note that a wide range of factors have the potential to influence annoyance and these include subjective, personal and attitudinal factors.

Background Noise Level
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. ($L_{A90,\,T}$).

Criterion Noise Level
The limit of Sound Pressure Level (with reference time interval as appropriate) which may be applied to a noise source, to the boundary of the activity, or to noise sensitive locations in the vicinity of the site.

Daytime

08:00 hrs to 22:00 hrs (night-time is regarded as the period: 22:00 hrs to 08:00 hrs).

Evening

19:00 hrs to 23:00 hrs.

Facade Level
Noise levels at locations 1m from the facade of a building are described by the term *Facade Levels* and are subject to higher noise levels than those in open areas (free-field conditions) due to reflection effects.

Free-field Conditions
These are conditions in which the radiation from sound sources is unaffected by the presence of any reflecting boundaries. 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.

Decibel (dB)
The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micropascals (20 µPa). 0 dB is the threshold of hearing, 140 dB is the threshold of pain. A change of 1 dB is detectable only under laboratory conditions. A change of 10 dB corresponds approximately to halving or doubling in the perceived loudness of sound.

dB(A)
Decibels measured on a sound level meter incorporating a frequency weighting (A-weighting) which alters the frequency (pitch) response of a measurement device, such as a sound level meter, to mimic the response of the human ear.

dB (Lin)$_{max\ peak}$
Instantaneous Maximum Peak sound pressure level measured in decibels on a sound level meter, without the use of a frequency weighting system.

Frequency
The number of vibrations or pressure fluctuations per second. The unit is Hertz (Hz).

Impulsive Noise
A noise of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.

$L_{Aeq,T}$
The equivalent steady sound level in dB containing the same acoustic energy as the actual fluctuating sound level over the given period, T.

$L_{A90,T}$
The noise level exceeded for 90% of the time interval, T. This level is generally taken to represent the 'background noise' level, however, depending on the circumstances, it can be a useful indicator of a typical floor level for continuous industrial noise.

$L_{A10,T}$
The noise level exceeded for 10% of the time interval, T. This level is representative of the typical peaks and it is most frequently used in the assessment of traffic noise.

$L_{Ar,T}$
The equivalent continuous A- weighted sound pressure level during a specified time interval, T, plus specified adjustments for tonal character and impulsiveness of the sound.

L_{AIeq}
This is the A-weighted sound pressure level, determined with time-weighting characteristic I. It can be used in the determination of an impulsive noise.

L_{den}

The day-evening-night level L_{den} in decibels (dB) is defined by the following formula:

$L_{den} = 10 \log {}^{1}/_{24} \{(12 * 10^{a}) + (4 * 10^{b}) + (8 * 10^{c})\}$
Where $a = 0.1\ L_{day}$, $b = 0.1\ (L_{evening} + 5)$, $c = 0.1\ (L_{night} + 10)$

in which:

L_{day}, $L_{evening}$, and L_{night} are A-weighted long-term values (as per ISO 1996-2: 1987) determined over all the day, evening, and night periods of a year as appropriate. The day is twelve hours long, the evening four hours, and the night eight hours.

Low Frequency Noise (LFN)

LFN is generally taken to mean noise below a frequency of about 100 to 150 Hz, and is usually associated with noise in the 40 – 60 Hz range.

Narrow Band Frequency Analysis

Frequency analysis of sound such that the frequency spectrum is very finely subdivided into narrow bands. The sensitivity of the method will be defined by the sophistication of the equipment used. The Fast Fourier Transform (FFT) analyser is often used to establish the presence or absence of tones at low frequencies.

Noise

Unwanted sound. Any sound which has the potential to cause disturbance, discomfort or psychological stress to a subject exposed to it, or any sound which has the potential to cause actual physiological harm to a subject exposed to it or physical damage to any structure exposed to it, is known as noise.

Noise Indicator

An indicator is a physical scale for the description of environmental noise, which has a relationship with a harmful effect.

Noise Sensitive Location (NSL)

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

${}^{1}/_{3}$ Octave Band Analysis

Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one third of an octave each. An octave is taken to be a frequency interval, the upper limit of which is twice the lower limit (in Hertz).

Peak Particle Velocity (PPV)
The maximum instantaneous velocity of a particle at a point during a given time interval. It is the unit which is usually used to assess vibration in relation to activities involving blasting. PPV correlates well with the degree of human perception to vibration, and with damage to property. The propagation of motion may be defined in terms of three mutually perpendicular components and these are generally measured simultaneously. The particle velocity will vary from zero to a maximum value - the peak particle velocity – which is expressed as millimetres per second (mm/s).

Pure Tone
A sound in which the sound pressure varies regularly at a single frequency over time.

Rating Level
The specific noise level, plus any adjustment for the characteristic features of the noise.

Residual Noise
The ambient noise remaining at a given position, in a given situation, when the specific source is suppressed to a degree such that it does not contribute to the ambient noise. Residual noise level is measured in terms of $L_{Aeq,T}$.

Root Mean Square (RMS)
The RMS value of a set of numbers is the square root of the average of their squares.

Sound Exposure Level (SEL or L_{AE})
This is 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.

Sound Power
The energy output from a source, i.e. the rate per unit time at which sound energy is radiated. It is measured in Watts.

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: 'the equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval ($L_{Aeq, T}$)'.

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

Tone
A noise with a narrow frequency composition. e.g. whine of an electrical motor.

Tonal Noise
Noise which contains a clearly audible tone, i.e. a distinguishable, discrete or continuous note (whine, hiss, screech or hum etc.). In determining whether a tonal adjustment applies, reference can be made to ISO 1996-2 (1987) - Section 4.1.

Vibration
Regularly repeated movement about a fixed point or an oscillation wherein the quantity is a parameter that defines the motion of a mechanical system.

Appendix II: Industrial Sectors Covered by this Guidance Note

This Guidance Note covers activities specified in the First Schedule to the Environmental Protection Agency Acts 1992 and 2003 and the Third and Fourth Schedules to the Waste Management Acts 1996 to 2003.

First Schedule to the Environmental Protection Agency Acts 1992 and 2003:

Activities to which Part IV applies.

1 Minerals and Other Materials

1.1.1 The production of asbestos.

1.1.2 The extraction, production and processing of raw asbestos, not included in paragraph 1.1.1.

1.2 The extraction of aluminium oxide from an ore, not included in paragraph 5.13.

1.3 The extraction and processing (including size reduction, grading and heating) of minerals within the meaning of the Minerals Development Acts 1940 to 1999, where an activity involves— (*a*) a metalliferous operation, or (*b*) any other operation where either the level of extracted or processed minerals is greater than 200,000 tonnes per annum or the total operational yield is greater than 1,000,000 tonnes, and storage of related mineral waste.

1.4 The extraction of peat in the course of business which involves an area exceeding 50 hectares.

2 Energy

2.1 The operation of combustion installations with a rated thermal input equal to or greater than 50 MW.

3 Metals

3.1.1 The production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2.5 tonnes per hour.

3.1.2 The initial melting or production of iron or steel, not included in paragraph 3.1.1.

3.2.1 The processing of ferrous metals: (*a*) hot-rolling mills with a capacity exceeding 20 tonnes of crude steel per hour, (*b*) smitheries with hammers the energy of which exceeds 50 kilojoule per hammer, where the calorific power used exceeds 20 MW, (*c*) application of protective fused metal coats with an input exceeding 2 tonnes of crude steel per hour.

3.2.2 The processing of iron and steel in forges, drawing plants and rolling mills where the production area exceeds 500 square metres, not included in paragraph 3.2.1.

3.3.1 The operation of ferrous metal foundries with a production capacity exceeding 20 tonnes per day.

3.3.2 The production, recovery, processing or use of ferrous metals in foundries having melting installations with a total capacity exceeding 5 tonnes, not included in paragraph 3.3.1.

3.4.1 The— (*a*) production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes, (*b*) smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc.) with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals.

3.4.2 The production, recovery or processing of non-ferrous metals, their compounds or other alloys including antimony, arsenic, beryllium, chromium, lead, magnesium, manganese, phosphorus, selenium, cadmium or mercury, by thermal, chemical or electrolytic means in installations with a batch capacity exceeding 0.5 tonnes, not included in paragraph 3.4.1.

3.5 The reaction of aluminium or its alloys with chlorine or its compounds, not included in paragraph 5.13.

3.6.1 The roasting or sintering of metal ore (including sulphide ore).

3.6.2 The calcining of metallic ores in plants with a capacity exceeding 1,000 tonnes per year.

3.7 Swaging by explosives where the production area exceeds 100 square metres.

3.8 The pressing, drawing and stamping of large castings where the production area exceeds 500 square metres.

3.9 Boilermaking and the manufacture of reservoirs, tanks and other sheet metal containers where the production area exceeds 500 square metres.

4 Mineral Fibres and Glass

4.1 The processing of asbestos, and the manufacture and processing of asbestos-based products.

4.2.1 The melting of mineral substances including the production of mineral fibres with a melting capacity exceeding 20 tonnes per day.

4.2.2 The manufacture of glass fibre or mineral fibre, not included in paragraph 4.2.1 or 4.3.

4.3 The manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day or 5,000 tonnes per year.

4.4 The production of industrial diamonds.

5 Chemicals

Production, for the purposes of the activities mentioned in paragraph 5.12 to 5.17, means the production on an industrial scale by chemical processing of substances or groups of substances mentioned in any of those paragraphs.

5.1 The manufacture of chemicals in an integrated chemical installation, not included in paragraphs 5.12 to 5.17.

5.2 The manufacture of olefins and their derivatives or of monomers and polymers including styrene and vinyl chloride, not included in paragraphs 5.12 to 5.17.

5.3 The manufacture, by way of chemical reaction processes, of organic or organo-metallic chemical products other than those specified in paragraph 5.2 and not included in paragraphs 5.12 to 5.17.

5.4 The manufacture of inorganic chemicals, not included in paragraphs 5.12 to 5.17.

5.5 The manufacture of artificial fertilisers, not included in paragraphs 5.12 to 5.17.

5.6 The manufacture of pesticides, pharmaceutical or veterinary products and their intermediates, not included in paragraphs 5.12 to 5.17.

5.7 The manufacture of paints, varnishes, resins, inks, dyes, pigments or elastomers where the production capacity exceeds 1,000 litres per week, not included in paragraphs 5.12 to 5.17.

5.8 The formulation of pesticides, not included in paragraphs 5.12 to 5.17.

5.9 The chemical manufacture of glues, bonding agents and adhesives, not included in paragraphs 5.12 to 5.17.

5.10 The manufacture of vitamins involving the use of heavy metals, not included in paragraphs 5.12 to 5.17.

5.11 The storage, in quantities exceeding the values shown, of any one or more of the following chemicals (other than as part of any other activity) and not included in paragraphs 5.12 to 5.17— methyl acrylate (20 tonnes); acrylonitrile (20 tonnes); toluene di-isocyanate (20 tonnes); anhydrous ammonia (100 tonnes); anhydrous hydrogen flouride (1 tonne).

5.12 The production of basic organic chemicals, such as (*a*) simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic), (*b*) oxygencontaining hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxy resins, (*c*) sulphurous hydrocarbons, (*d*) nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates, (*e*) phosphorus-containing hydrocarbons, (*f*) halogenic hydrocarbons, (*g*) organometallic compounds, (*h*) basic plastic materials (polymers, synthetic fibres and cellulose-based fibres), (*i*) synthetic rubbers, (*j*) dyes and pigments, (*k*) surface-active agents and surfactants.

5.13 The production of basic inorganic chemicals, such as: (*a*) gases, such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride, (*b*) acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids, (*c*) bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide, (*d*) salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate, (*e*) non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon , silicon carbide.

5.14 The production of phosphorous-based, nitrogen-based or potassium-based fertilisers (simple or compound fertilisers).

5.15 The production of basic plant health products and of biocides.

5.16 The use of a chemical or biological process for the production of basic pharmaceutical products.

5.17 The production of explosives.

6 Intensive Agriculture

6.1 The rearing of poultry in installations, whether within the same complex or within 100 metres of the same complex, where the capacity exceeds 40,000 places.

6.2 The rearing of pigs in an installation, whether within the same complex or within 100 metres of the same complex, where the capacity exceeds— 750 places for sows in a breeding unit, or 285 places for sows in an integrated unit, or 2,000 places for production pigs. In this paragraph— ‘breeding unit’ means a piggery in which pigs are bred and reared up to 30kg in weight; ‘integrated unit’ means a piggery in which pigs are bred and reared to slaughter; ‘production pig’ means any pig over 30kg in weight which is being fattened for slaughter; ‘sow’ means a female pig after its first farrowing.

7 Food and Drink

7.1 The manufacture of vegetable and animal oils and fats where the capacity for processing raw materials exceeds 40 tonnes per day, not included in paragraph 7.8.

7.2.1 The treatment and processing of milk, the quantity of milk received being greater than 200 tonnes per day (average value on a yearly basis).

7.2.2 The manufacture of dairy products where the processing capacity exceeds 50 million gallons of milk equivalent per year, not included in paragraph 7.2.1.

7.3.1 Brewing (including cider and perry production) in installations where the production capacity exceeds 25 million litres per year, not included in paragraph 7.8.

7.3.2 Distilling in installations where the production capacity exceeds the equivalent of 1,500 tonnes per year measured as pure alcohol, not included in paragraph 7.8.

7.3.3 Malting in installations where the production capacity exceeds 100,000 tonnes per year, not included in paragraph 7.8.

7.4.1 The operation of slaughterhouses with a carcass production capacity greater than 50 tonnes per day.

7.4.2 The slaughter of animals in installations where the daily capacity exceeds 1,500 units and where units have the following equivalents— 1 sheep = 1 unit, 1 pig = 2 units, 1 head of cattle = 5 units, and not included in paragraph 7.4.1.
7.5 The manufacture of fish-meal and fish-oil, not included in paragraph 7.8.
7.6 The manufacture of sugar, not included in paragraph 7.8.
7.7.1 The disposal or recycling of animal carcasses and animal waste with a treatment capacity exceeding 10 tonnes per day.
7.7.2 The processing (including rendering) of animal carcasses and by-products, not included in paragraph 7.7.1.
7.8 Treatments or processes for the purposes of the production of food products from— (*a*) animal raw materials (other than milk) with a finished product production capacity greater than 75 tonnes per day, (*b*) vegetable raw materials with a finished product production capacity greater than 300 tonnes per day (average value on a quarterly basis).

8 Wood, Paper, Textiles and Leather

8.1 The production of paper pulp, paper or board (including fibre-board, particle-board and plywood) with a production capacity exceeding 20 tonnes per day.
8.2 The production of pulp from timber or other fibrous materials.
8.3 The treatment or protection of wood, involving the use of preservatives, with a capacity exceeding 10 tonnes of wood per day.
8.4 The manufacture of synthetic fibres, not included in paragraph 5.12.
8.5.1 The pre-treatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tonnes per day.
8.5.2 The dyeing, treatment or finishing (including moth-proofing and fireproofing) of fibres or textiles (including carpet) where the capacity exceeds 1 tonne per day of fibre, yarn or textile material, not included in paragraph 8.5.1.
8.6.1 The tanning of hides and skins where the treatment capacity exceeds 12 tonnes of finished products per day.
8.6.2 The fell-mongering of hides and tanning of leather in installations where the capacity exceeds 100 skins per day, not included in paragraph 8.6.1.

9 Fossil Fuels

9.1 The extraction, other than offshore extraction, of petroleum, natural gas, coal or bituminous shale.
9.2 The handling or storage of crude petroleum, not included in paragraph 9.3.1 or 9.3.2.
9.3.1 The operation of mineral oil and gas refineries.
9.3.2 The refining of petroleum or gas, not included in paragraph 9.3.1.
9.4.1 The operation of coke ovens.
9.4.2 The operation of coal gasification and liquefaction plants.
9.4.3 The production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitization.
9.4.4 The pyrolysis, carbonisation, gasification, liquefaction, dry distillation, partial oxidation or heat treatment of coal, lignite, oil or bituminous shale, other carbonaceous materials or mixtures of any of these in installations with a processing capacity exceeding 500 tonnes per day, not included in paragraph 9.4.1, 9.4.2 or 9.4.3.

10 Cement

10.1 The production of cement.

11 Waste

11.1 The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this Schedule in respect of which a licence or revised licence under Part IV is in force or in respect of which a licence under the said Part is or will be required.

12 Surface Coatings

12.1 Operations involving coating with organo-tin compounds, not included in paragraph 12.2.1 or 12.2.2.

12.2.1 The surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating, with a consumption capacity of more than 150 kg per hour or more than 200 tonnes per year.

12.2.2 The manufacture or use of coating materials in processes with a capacity to make or use at least 10 tonnes per year of organic solvents, and powder coating manufacture with a capacity to produce at least 50 tonnes per year, not included in paragraph 12.2.1.

12.3 The surface treatment of metals and plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30 m^3.

13 Other Activities

13.1 The testing of engines, turbines or reactors where the floor area exceeds 500 square metres.

13.2 The manufacture of integrated circuits and printed circuit boards.

13.3 The production of lime in a kiln.

13.4.1 The manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, or with a kiln capacity exceeding 4 m^3 and a setting density per kiln exceeding 300 kg/m^3.

13.4.2 The manufacture of coarse ceramics including refractory bricks, stoneware pipes, facing and floor bricks and roof tiles, not included in paragraph 13.4.1.

Third Schedule to the Waste Management Acts 1996 to 2003

Waste Disposal Activities

1. Deposit on, in or under land (including landfill).
2. Land treatment, including biodegradation of liquid or sludge discards in soils.
3. Deep injection of the soil, including injection of pumpable discards into wells, salt domes or naturally occurring repositories.
4. Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.
5. Specially engineered landfill, including placement into lined discrete cells which are capped and isolated from one another and the environment.
6. Biological treatment not referred to elsewhere in this Schedule which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1 to 5 or paragraphs 7 to 10 of this Schedule.
7. Physico-chemical treatment not referred to elsewhere in this Schedule which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1 to 5 or paragraphs 8 to 10 of this Schedule (including evaporation, drying and calcination).
8. Incineration on land or at sea.
9. Permanent storage, including emplacement of containers in a mine.
10. Release of waste into a water body (including a seabed insertion).
11. Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.
12. Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.
13. Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.

Fourth Schedule to the Waste Management Acts 1996 to 2003

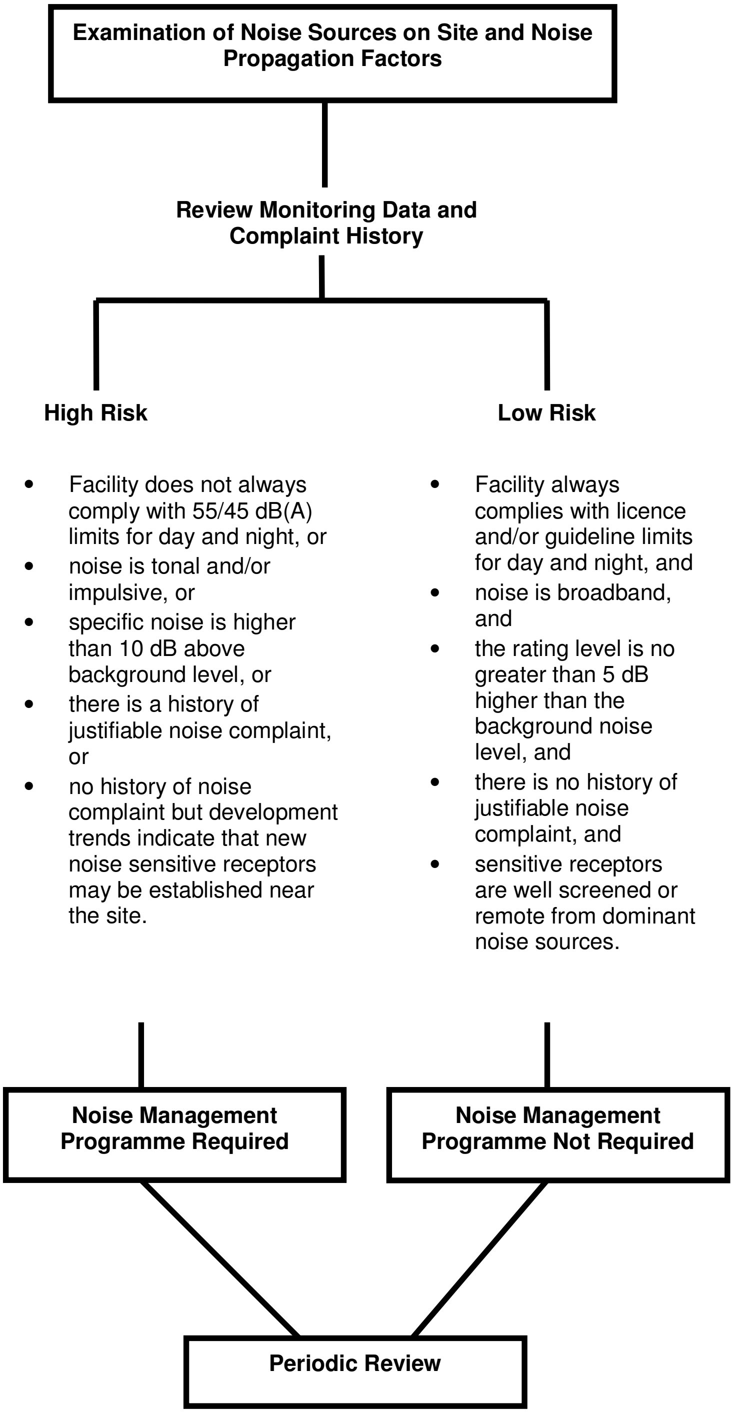
Waste Recovery Activities

1. Solvent reclamation or regeneration.
2. Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological processes).
3. Recycling or reclamation of metals and metal compounds.
4. Recycling or reclamation of other inorganic materials.
5. Regeneration of acids or bases.
6. Recovery of components used for pollution abatement.
7. Recovery of components from catalysts.
8. Oil re-refining or other re-uses of oil.
9. Use of any waste principally as a fuel or other means to generate energy.
10. The treatment of any waste on land with a consequential benefit for an agricultural activity or ecological system.
11. Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule.
12. Exchange of waste for submission to any activity referred to in a preceding paragraph of this Schedule.
13. Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.

Appendix III: Some Practical Examples of Rating Levels

L_{Aeq} (dB)	Tonal Assessment	Impulsive Assessment	Correction or Penalty (dB) and methodology	Rating Level $L_{Ar,T}$ (dB)
55	Significant tonal noise, clearly audible and is an essential acoustic feature of the noise. The level in one 1/3rd octave band is 5 dB (or more) higher than the level in the two adjacent bands.	Impulsive noise clearly present and noticeable.	+ 5 Clause 8.2 BS 4142 and verified by Section 4 of ISO 1996/2 (1987) and Annex C of ISO 9612 (1997)	60
65	Tonal noise not clearly audible and is not a clear acoustic feature of the noise.	Impulsive noise clearly present and/or noticeable as periodic clatters.	+ 5 Clause 8.2 BS 4142 and verified by Section 4 of ISO 1996/2 (1987) and Annex C of ISO 9612 (1997)	70
40	Slight tonal noise barely audible and not a dominant or essential acoustic feature of the noise. The level in one 1/3rd octave band is 4 dB higher than the level in the two adjacent bands.	Impulsive noise not clearly audible and/or noticeable. Noise level perceived as generally broad-band and not irregular enough to attract attention.	0 Clause 8.2 BS 4142 and verified by Section 4 of ISO 1996/2 (1987)	40

Appendix IV: Factors to Consider in Developing a Noise Management Programme



Appendix V: Noise Complaints

Licence conditions will generally require all environmental noise complaints to be logged and investigated. 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 a noise sensitive location becomes excessive. Once a complaint has been made, a detailed record of all pertinent information should be logged 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 and in particular wind speed and direction; and
- investigative and follow-up action arising from the complaint.

In all cases an investigation should be undertaken within a reasonable time-frame 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 time frame for implementation.

For intermittent noise sources, especially when the noise sensitive location is a considerable distance from the offending noise source, meteorological conditions can be a determining factor. Where there may be a question as to the bona fides of the complaint, an objective assessment (e.g. utilising BS 4142 methodology) should be undertaken and a judgement made as to whether reasonable grounds for complaint exist.

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.

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 150 Hz, and is usually associated with noise in the 40 to 60 Hz range.

Many of the assessment and control techniques which pertain to everyday noise sources do not apply to low frequency noise. In 2001 a report was produced by Casella Stranger 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 25 dB at 100 Hz, 40 dB at 50 Hz, and 70 dB at 20 Hz.

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 points 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

There is little official guidance/standards with regard to the assessment of LFN and a number of factors complicate the measurement and assessment of such noise, particularly at frequencies below 20 Hz. These include the following:

- individuals appear to vary considerably in their hearing sensitivity at low frequencies;
- LFN may be difficult to measure with conventional sound measurement equipment; and

- even when identified, the nature of LFN is such that it is often very difficult to locate the source, which can sometimes be quite distant from the receiver.

As the A-weighting network significantly attenuates low frequencies, any measurements made of LFN should be with the instrument set to linear (L). For a preliminary analysis, measurements should be made using 1/3 octave band analysis. More detailed analysis would require the use of narrow band analysis or even a Fast Fourier Transform (FFT) analyser. It is also preferable to use a real time analyser so that instantaneous variations in level and frequency can be observed as they happen.

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. clocks, refrigerators etc. If this does not identify the source then consideration should be give to external sources or sources in adjacent buildings.

A low frequency noise investigation protocol was established in the UK in 1994 and the 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.

Footnotes

Since the publication of the 2001 report (i.e. Casella Stranger/ DEFRA), there have been some significant developments. It is now recognized that heretofore instrument standards were somewhat vague with regard to linear weightings, e.g. the frequency ranges covered and the permissible deviations from a flat response were not specified by manufacturers.

In order to overcome certain anomalies pertaining to linear weighting the 2003 standard IEC 61672 defines a new frequency weighting, known as the Z weighting. The Z weighting is in effect a strictly specified 'linear' weighting, however, all instruments using a Z weighting under identical conditions will give the same measurement results. Pending the widespread adoption of the Z weighting, the use of C weighting is advocated with due recognition given to its limitations at the extremes of the frequency range.

A 2003 report for DEFRA provides a good overview of LFN and details of assessment procedures adopted in other EU member states. The report, entitled *'A Review of Published Research on Low Frequency Noise and its Effects'* may be accessed on the

DEFRA website (www.defra.gov.uk). The report was prepared by Leventall, G. et al. and published in May 2003.

The following two reports on LFN, prepared by researchers at the University of Salford, were published in 2005 and are also accessible via the DEFRA website:

Moorhouse, A., Waddinton, D. & Adams, M. (2005) *Proposed criteria for the assessment of low frequency noise disturbance*. (Report prepared for Defra, contact no. NANR45). University of Salford. (February 2005).

Moorhouse, A., Waddinton, D. & Adams, M. (2005) *Procedure for the assessment of low frequency noise complaints*. (Report prepared for Defra, contact no. NANR45). University of Salford. (February 2005).