ENVIRONMENTAL NOISE SURVEY

GUIDANCE DOCUMENT

Environmental Protection Agency
An Ghniomhaireacht um Chaomhnu Conmshaoil
PO Box 3000, Johnstown Castle Estate, County Wexford, Ireland

Telephone: +353-53-60600 Fax: +353-53-60699
Email: info@epa.ie Website: http://www.epa.ie

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PREFACE

This Guidance Document is designed to provide acoustic guidelines to the operators of activities which are listed in the First Schedule of the Environmental Protection Agency Act, 1992. Such activities are normally subject to an integrated pollution control licence.

As part of the Integrated Pollution Control (IPC) licensing system, certain industrial activities may have conditions attached to their IPC licences which effect control over emissions of noise. Noise control limits are generally stipulated by specific licensing conditions. Limits may be imposed at boundary positions and/or at Noise Sensitive Locations (NSLs). In addition, certain limits may be applied to specific sources of noise on-site.

In instances where there is a requirement to undertake an Annual Noise Survey, the licensee is generally required to consult with the Environmental Protection Agency (EPA) in connection with the timing, nature and extent of the survey. Generally a proposed survey programme should be submitted to the Agency in advance of the survey being carried out. The wording of a typical licence condition would read as follows:

> '*The licensee shall carry out a noise survey of the site operations annually. The licensee shall consult with the Agency on the timing, nature and extent of the survey and shall develop a survey programme to the satisfaction of the Agency. The survey programme shall be submitted to the Agency in writing at least one month before the survey is to be carried out. A record of the survey results shall be available for inspection by any authorised persons of the Agency, at all reasonable times and a summary report of this record shall be included as part of the AER.*'

It is recognised that environmental noise monitoring and assessment can in certain instances be both technically demanding and complex. The Guidance Document sets out the Agency's requirements with regard to Annual Noise Surveys and outlines survey and assessment methodologies which fulfil the general licensing requirements with regard to noise. The document does not consider vibration measurement or assessment.

While the findings of an Annual Noise Survey will need to be presented in a detailed report, the format of such reports has not been addressed in this document. A checklist for drafting such reports is, however, included.

This Guidance Document should not be considered as a legal document.

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The Agency would like to take this opportunity to thank the Institute of Engineers (IEI) for their comments during the drafting of this note.

CONTENTS

1. Introduction:

Many facilities within the IPC licensing regime are subject to an Annual Noise Survey. While every licensed facility needs to be considered on a case by case basis, this Guidance Document outlines survey and assessment methodologies which generally fulfil the Agency's requirements. It is important to note that this Guidance Document cannot be considered in isolation and it must be interpreted in relation to the site-specific conditions pertaining to each facility. Reference must also be made to relevant acoustical standards (principally ISO and British Standards). While this Guidance Document in no way attempts to interpret the relevant provisions of these standards for every particular case it does provide an overview of the methodology and assessment approach that is required for the majority of Annual Noise Surveys.

This Guidance Document should be read in conjunction with the Agency's 'Guidance Note for Noise in Relation to Scheduled Activities' (EPA, 1995). However, this document anticipates some changes to the EPA's policy in line with certain obligations which arise under the 'Environmental Noise Directive' (Directive 2002/49/EEC).

2. The Scope of the Annual Noise Survey:

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

- The precise wording of the IPC licence conditions in relation to noise.
- Whether noise limits have been stipulated for boundary and/or NSL positions.
- Whether noise limits have been stipulated for specific items of equipment/plant.
- Local environmental and acoustic conditions (e.g., localised or extraneous noise sources).
- Relevant changes at the facility (e.g. plant or operational changes) since the last noise survey.

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

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

- The location, proximity and sensitivity of Noise Sensitive Locations (NSLs) and receptors.
- The likelihood of noise emissions causing annoyance and/or disturbance.
- The nature and character of the locality and the background noise (ambient noise in the absence of noise from the specific facility).
- The presence or absence of topographical features and/or buildings or other such structures which may help to attenuate the noise emissions.
- The characteristics of the noise sources at the facility – e.g., is the noise typically broad-band, tonal and/or impulsive.
- The normal operating times of noise sources at the facility and any possible variations or irregular emissions, e.g., intermittent emissions even of short duration can cause annoyance and/or disturbance.

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

In some cases, the licensed activity will only operate during normal daytime hours. To this end it is important to note that daytime is defined in many licenses (and in the current Agency's Guidance Note for Noise in Relation to Scheduled Activities) as 08:00 hours to 22:00 hours and night-time is defined as 22:00 to 08:00.

The Agency's current licensing policy generally stipulates a daytime limit and a night-time limit, however, the 'Environmental Noise Directive' (Directive 2002/49/EC) which came into effect on the 25 June 2002 may have long-term implications for this policy.

In instances where a facility does not normally operate during night-time, certain noise sources may function continuously (e.g. refrigeration plant and/or compressors). In most situations the survey work will need to be undertaken during daytime and night-time, and particularly for the initial noise survey. Only in rare situations where no noise sources operate during night-time will a daytime survey suffice. In any event the timing of the survey work is a critical factor. It is important that the survey is undertaken during a period which is representative of typical or preferably worst-case operational conditions.

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

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

3. Competent Person:

The person who carries out the survey work must be a 'competent person'. It is important that the competent person is involved in determining the scope and extent of the noise survey as well as undertaking the field work. 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.
- 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.

4. Survey, Methodologies and Assessment Procedures:

Monitoring for compliance with the noise emission conditions of an IPC Licence should be primarily based upon International Standard ISO 1996: Acoustics Description and Measurement of Environmental Noise - or a method approved by the Agency. In certain instances, some of the assessment procedures and methodologies outlined in BS 4142 and BS 5228 (Appendix III) may be utilised as part of the overall strategy.

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 15 minutes during night-time. Regard should be had to any time limits specified in the IPC licence. These may need to be supplemented with shorter or longer sampling intervals in certain cases.

Ideally, sampling over different days and at different times during the day will help to ensure that the survey is statistically representative. However, there are many practical constraints militating against this. Where noise emissions are relatively steady, a series of measurements should be undertaken over a typical period of 4 hours during daytime and over a minimum of 2 hours during night-time, particularly for larger facilities with numerous external noise sources. As stated in Section 3, it is important that the survey is undertaken during a period which is representative of typical or worst-case operational conditions. If this is not sensible or practicable on account of: weather conditions, process cycles, extraneous noise interference or any other reason, then this should be stated.

The location of some of the monitoring positions should, where practicable, be the same as those used for baseline noise studies from which any noise emission controls have been set. Alternatively, measurement positions which were used during a noise survey at the time of the IPC licence application, should be retained where practicable. This will allow temporal variations to be assessed over a long-term period.

The selection of monitoring positions is further addressed in Section 5 below, however, in practice these will generally include points along the site boundary or positions at specified NSLs. Intervening ground conditions, buildings, distance and other factors affect noise propagation from a facility. Significant variations from the prevailing conditions applicable during proceeding surveys should be noted. It should be remembered that one of the objectives of the survey should be to compare the measured noise levels at the current time with those at a previous time. All other factors should be as close as possible to being the same, at least over the representative sampling interval or period.

Measurements should be attended in most cases in order that the numerical values obtained can be confirmed by the assessment personnel as being wholly attributable to the facility (activity) under investigation. Attended measurements will facilitate the identification of extraneous sources and tonal elements. In certain cases, automatic unattended logging of noise levels may be appropriate, e.g., boundary noise measured very close to a facility where there is no doubt as to the source of the noise. In the latter case, automatic monitoring of the weather conditions will be required. (see Section 10 below on Weather Conditions).

5. Monitoring Positions:

In the first instance regard must be had to the relevant conditions in the IPC licence. Generally limits will be specified for NSLs, boundary positions or in some instances for specified pieces of equipment or plant. In the latter case, generally, a specified measurement position is given in a schedule to the IPC Licence.

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

Given that the primary objective of the Annual Noise Survey is to determine the level of compliance, the measurement positions should include those positions which are most affected by the facility's emissions. The 'worst-case' sampling positions should always be selected for monitoring purposes. This can be achieved in practice by walking the site boundary, for example, and undertaking a series of short-term sound level measurements. The noisiest measurement positions can then be selected for monitoring purposes and appropriate and representative intervals can be sampled (typically 15 minute or 30 minute duration).

In instances, where the measured boundary levels at the noisiest positions are clearly in compliance with licence limits, there should be no onus to undertake extensive measurements along the site boundaries. If for some reason, however, the noisiest position is unrepresentative or atypical, a series of supplementary positions can be selected to demonstrate this. In most situations, the monitoring positions should be representative of different compass points along the boundary. Electrical interference from power cables and radio transmitters etc. should be avoided.

With regard to off-site measurements, appropriate receptor positions should be selected with reference to the definition of 'NSL'. However, in instances where only a boundary limit applies and the licensed activity causes no perceptible impact at NSLs, there should be no obligation to undertake measurements beyond the site boundary. However, even where the licensed activity is assumed to cause no perceptible impact at any NSL, it is worthwhile to periodically reconsider or re-test this assumption. In this regard, it is noteworthy that an absence of complaints does not necessarily mean an absence of any noise impacts.

Although, not expressly stated, the noise limits which are imposed by IPC license conditions are generally 'free-field' levels, i.e., levels where the influence of reflections have been minimised. Whenever possible, therefore, the noise measurement should be carried out at least 3.5 metres from any reflecting structure other than the ground. The preferred position for the microphone is 1.2 to 1.5 metres above ground level.

In situations where measurements are being taken at a NSL, generally the boundary of the NSL (e.g. just outside the garden of a domestic house) can be the most useful monitoring position. This helps to avoid the influence of domestic noise and also eliminates the need for trespass onto private property etc. In certain instances, however, monitoring at the boundary of a NSL may be supplemented by measurements close to the building of interest (i.e., façade levels). In the case of the latter, the appropriate measurement position would be 1 to 2 meters from the façade and 1.2 to 1.5 metres above each floor level of interest. Where it is proposed to undertake noise monitoring late at night, then the notification of the local land owner(s) and neighbour(s), should be considered.

6. Measurement Equipment:

Noise emission levels generally have a maximum tolerance of 2 dB for short-term occasional exceedences and this is generally specified in the IPC licence. It is therefore essential to ensure that the equipment used or monitoring can be guaranteed to perform within this tolerance.

The four grades of designated (Types 0, 1, 2 and 3) Sound Level Meter (SLM) differ only in the tolerances allowed. Tolerances generally broaden as the type number increases. A Type 1 SLM is the most appropriate for survey work. The SLM must have a recent (annual or, as a minimum, biennial) traceable calibration. It is equally important that the SLM is checked in the field before and after any measurements by the use of an acoustic calibrator with a recent (annual or, as a minimum, biennial) traceable calibration.

The principal noise index to be recorded will generally be the $L_{Aeq,\ T}$, the A-weighted equivalent continuous level averaged over a specified time period, T (the sampling interval). This time period must be specified for the measurement result to be meaningful. Most modern instrumentation will provide two different exponential time weightings – 'fast' (with a nominal exponential-time constant of 125 milliseconds) and 'slow' (nominal exponential time constant of 1 second). Fast, is generally the preferred time-weighting, especially for statistical data and for variable noise levels.

If there are noticeable significant tonal or impulsive elements in the noise, then these may need to be measured and analysed in a more sophisticated manner. A 'significant' tone or impulsive element is one that is clearly audible at a level near or above the general ambient noise level. Tonal analysis requires the use of a third octave or narrow band frequency analyser.

7. Noise Indices:

One of the fundamental requirements of the Annual Noise Survey is to determine whether or not the licensed activity complies with the criterion noise level. To this end, the long term mean value of the criterion noise level should not be exceeded. Occasional exceedences of 2 dB(A) are acceptable. There is no relaxation on the requirement that tonal or impulsive noise should be avoided at night.

While, in most situations a subjective assessment on the presence of tones and impulsive elements can be made, it is best that this is verified using objective assessment procedures, e.g. the use of 1/3 octave band analysis and the use of the impulse exponential-time weighting (Sections 4.1.3 and 4.1.4 of ISO 1996/2).

It is envisaged that IPC licence conditions may eventually be framed in accordance with the 'selected common noise indicators' as set out in the Environmental Noise Directive (2002/49/EC). However, most IPC licence conditions refer specifically to a limit value specified in terms of $L_{Aeq,T}$.

Thus, the criterion noise level is generally specified in terms of $L_{Aeq,T}$, however, in instances of tonal or impulsive noise, the rating level ($L_{Ar,T}$) should additionally be reported in accordance with ISO 1996/2 (1987).

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

While modern instrumentation will permit the logging and recording of a substantial number of indices, the following standardised parameters are considered to be important $L_{A1,T}$, $L_{A10,T}$, and $L_{A90,T}$. Where the noise emissions are characterised by a number of discrete events, the additional use of $L_{A,max}$ and A-weighted Sound Exposure Level (SEL or L_{AE}) is recommended. Alternative indices may be used to supplement the foregoing and these should all be detailed in a Noise Measurement Report. Guidance on the content and layout of such reports is given in the form of a checklist which is presented in Appendix I.

8. Noise Attributable to a Particular Activity:

The conditions of any IPC licence apply to one specific facility, i.e. the licensed activity. However, it is possible that over time other industries or sources of noise will encroach on an area that was previously only affected by the licensed facility. This produces some serious difficulties in measuring the noise 'attributable'. SLMs are not directional and do not specifically measure the noise from the direction in which they are pointed. However, there are several techniques that can be applied to assist in identifying noise 'attributable' to a particular source. These techniques generally require a high level of competence in acoustic measurement.

For facilities that operate continuously for 24 hours, it may be appropriate to measure at a time when all (or most) other noises have subsided. This will often mean measuring late at night when general traffic noise has reduced. Where the specific facility noise can be temporarily eliminated or subdued, it is possible to estimate the 'specific noise' (refer to BS 4142 :1997) by measuring the noise level with and without the specific facility running. The use of pausing techniques and short-term sampling intervals may also help to ascertain the noise attributable to the facility of interest.

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

9. Interpretation of the Results:

The results of the Annual Noise Survey must be presented to the Agency and guidance on the contents of the report is presented in Appendix I. The interpretation of the monitoring results will form a critical part of the report and it should include a general description of the measurements including a summary of the levels of the various noise criteria for the relevant time periods. Special note should be made of the character of the sound and the presence of tones (continuous distinguishable notes such as a whine or a hiss) or impulsive elements (such as bangs, clanks, etc.). The report should highlight whether the rating level was adjusted to account for these tonal or impulsive elements. Subjective comments on audibility and the dominance of noise sources should also be included along with difficulties in identifying sources etc.

For some noise surveys, the $L_{A90,\,T}$ index may be used to give a good indication of the actual noise output from the site, where the noise emissions on site are relatively steady.

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

10. Weather Conditions:

Ideally, measurements should be taken in 'neutral' weather conditions. This means in the absence of wind and precipitation, and ideally in conditions of standard temperature and pressure. Clearly, these conditions very rarely apply. However, the potential errors in measurements are small if reasonable care is taken to avoid the worst excesses of the elements. The SLM must be fitted with a windshield under all circumstances. An average wind speed of less than 5m/sec is the preferred limit when noise measurements are being taken, with 7m/sec an upper limit. In all cases, care should be taken to avoid measurements so close to objects as to give rise to wind-derived noises, e.g. trees, pylons, etc.

Wind speed and wind direction have the potential to affect the noise measurements. The prevailing weather conditions at the time of measurement should be noted and recorded in the survey report. In certain instances a meteorological station may be located close to the monitoring position and in such cases the available met data should be accessed and referred to in the noise measurement report. Any on-site observations may be supplemented with the use of hand-held anemometers.

Measurements should generally be avoided in rainy or dense foggy conditions. The use of protective covers for SLMs can create noise from impacting raindrops. Common sense must be used at all times to protect the instrumentation and the prevailing conditions must be clearly stated to allow a qualitative judgement to be made on the validity of the measurements. In general, noise attributable to wind and or rain should be at least 10 dB below the noise source being measured; otherwise the measurements may be invalid.

Appendix I

Noise Measurement Report Checklist:

The conditions of the measurements should be carefully documented in a formal measurement report. The following information should typically be included:

- The manufacturer, model type and serial number of the sound level meter, calibrator and microphone used.
- The type of windshield and other microphone attachments used.
- The date the equipment was last calibrated to a traceable standard.
- A statement of on-site calibration before and after the measurements.
- The frequency weighting networks and meter responses used.
- A description of the measurement site and of the range of sound sources including the type of sound (continuous, intermittent, impulsive, tones).
- Measures to exclude extraneous noise and reference to the methodologies followed throughout the survey.
- A map of the measurement site showing the locations of the measurement positions.
- Details of the intervening ground between sources and measurement positions and the presence of barriers etc.
- The time and date of the measurement.
- A description of the meteorological conditions.
- The background noise level (where practicable).
- The names of the person/s that undertook the survey and drafted the survey report.

In addition to the above items, the noise measurement report should typically include tabular values of the measured and rated noise levels for each measurement period. Comments should also be made regarding the variation of these criteria throughout the measurement period. Where one third octave band or narrow band frequency analysis has been undertaken, the frequency spectrum should be enclosed with the report.

Finally, the measurement report should include a statement of compliance or otherwise with the licence conditions.

Appendix II

Glossary of Terms:

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

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 long-term mean value of the noise level that must not be exceeded. This is generally stipulated in the IPC licence and it may be applied to a noise source, a boundary of the activity or to noise sensitive locations in the vicinity of the facility.

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 (the unit of frequency is the Hertz, Hz).

dB (decibel):
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 micro-pascals (20 μPa).

dBA or dB(A):
An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

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.

Hz (Hertz):
The unit of sound frequency in cycles per second

Impulsive Noise:
A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background. In determining whether a tonal adjustment applies, reference must be made to ISO 1996-2 (1987) - Section 4.1.

Impulse Exponential – Time-Weighting:
This is a time-weighting which is available on some sound level meters and it represents an arbitrary compromise in an attempt to provide a means to measure the sound level of short-duration impulsive sounds. Impulse time-weighting has a design goal exponential-time constant of 35 ms for sound signals that increase with increasing time and 1.5 seconds for sound signals that decrease with increasing time.

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

L_{Amax}:
The maximum RMS, A-Weighted sound pressure level occurring within a specified time period; the time weighting fast or slow is usually specified.

Noise:
Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a subject exposed to it, or any sound, that could 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 Sensitive Location:
Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.

Rating level ($L_{Ar,T}$) : 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}):
The is the 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.

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 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.

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 must be made to ISO 1996-2 (1987) - Section 4.1.

Appendix III

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