Guidelines for Environmental Noise Measurement and Assessment

Nova Scotia Environment and Climate Change

Effective: October 1st, 2023

NOVA SCOTIA

Contents

1.0 About the Guidance

These guidelines are applicable to activities that are regulated under the *Activities Designation Regulations*. They are in place to assist proponents who are required under the *Environment Act* or regulations made pursuant to the *Act* to undertake environmental noise measurement and assessment activities.

Approvals are issued based on the information provided to the Department. Noise assessments must, as a minimum, demonstrate the impacts from the maximum noise anticipated from the proposed activity. In all cases, monitoring and modelling assessments must show compliance with the permissible sound levels and/or any other appropriate Provincial environmental standards with acceptance from the Department. If there is any discrepancy between requirements outlined in this document and conditions of a regulated activity's Approval, the discrepancy shall be resolved in favour of the Approval.

Municipalities continue to be responsible for many environmental noise sources from activities that are not covered under the *Act*. More stringent requirements may exist in municipal bylaws and/or federal requirements. It is the proponents' responsibility to understand and abide by these guidelines and other criteria found in municipal bylaws and/or federal requirements. Occupational noise is covered by other regulations.

2.0 Relevant Legislation

Environment Act

3(au) "**substance**" means… (ii) any **sound**, vibration, heat, radiation or another form of energy…

73 The Minister may

(a) classify releases for the purpose of this Part and exempt any release or any class of release from the application of this Part and attach terms and conditions to any such exemption;

(b) prescribe the concentration, amount, level and rate, including the maximum concentration, amount, level and rate of a **substance** that may be released into the environment;

(ba) establish procedures respecting the conducting of sampling, analysis, tests, measurements or monitoring of **substances**;

(c) determine the manner in which a report of a release of a **substance** is to be made and the contents of the report. 1994-95, c. 1, s. 73; 2006, c. 30, s. 24

3.0 Definitions

Ambient refers to the **noise** level at a **receptor** when all **noise** sources are operating.

A-weighted sound level is a frequency filter that emphasises middle sound frequencies, similar to what the human ear responds to.

Baseline refers to the existing sound level without any contribution from the **target noise source**. Baseline sound levels may be measured before a **target noise source** is in existence, or when the **target noise source** is not operational. If it is not possible to measure baseline sound levels without the **target noise source**, noise measurements should be taken upwind of the **target noise source**.

Class 1 means that the measurement instrumentation and its components have been individually lab-certified to meet all the requirements of an applicable standard, such as the International Electrotechnical Commission (IEC) standard 61672 for **Class 1** performance.

Compliance period is a period of time over which the one-hour **equivalent sound level** (see **Leq)** and logarithmic mean **impulsive sound level** (see $\mathbf{L_{LM}}$) must not exceed the **permissible sound level**. See Appendix 1.

Comprehensive sound level is a composite of all sounds from many different sources at the point of measurement and/or modelled **receptor**.

C-weighted sound level is a frequency filter that is more sensitive to lower frequency sounds than is the **A-weighted** sound level and is used to assess **low frequency noise**.

dBA is the **sound pressure level** filtered through the **A-weighted** filter.

dBAI is the peak **sound pressure level** for **impulsive noise** filtered through the **A-weighted** filter.

dBC is the **sound pressure level** filtered through the **C-weighted** filter.

Decibel (dB) is a unit of measured **sound pressure level** and is represented on a logarithmic scale.

Equivalent sound level (Leq) is a single-number representation of the average, cumulative acoustical energy over a specified time interval. **Leq** can be followed by a letter suffix to indicate either **A-weighted** or **C-weighted** measurements and a time-period in brackets. For example, $\mathbf{LAeq}_{(1\ hour)}$ is the average cumulative **A-weighted sound level** over a 1-hour period.

Impulsive noise means sound of short duration, usually less than one second, with an abrupt onset and rapid decay. It is characterized by short bursts of sound that typically have large values of peak acoustical energy. Measurements for comparison with **permissible sound levels** are made using the **A-weighted** filter to give individual peak sound levels (**dBAI**). The number of impulsive bursts is limited each hour over the 0700 hr to 2300 hr time period and the geographic area in which they occur (Appendix 6). In addition, the logarithmic mean impulsive

sound level (L_{LM}) of the **dBAI** for each **compliance period** must be met (Appendix 1). The LLM can be written algebraically as:

$$L_{LM} = 10 \log_{10} \left[\frac{1}{N} \left(10^{dBAI_1/10} + 10^{dBAI_2/10} \ldots + 10^{dBAI_N/10} \right) \right]$$

Back-up alarms are not considered to be impulsive noises.

LA_{90} is the noise level that is exceeded 90% of the time during the measurement period. It is commonly referred to as the background level and is calculated as the mode (i.e., most common measured **LA_{90}** and not the lowest).

LA_{Max} is the maximum **A-weighted noise** level for a given time period.

Leq and **LAeq** see **equivalent sound level**.

L_{LM} see **impulsive noise**.

Low Frequency Noise (LFN) is where a **sound** has a defined **tonal component** at or below a frequency of 250 Hz, and the difference between the overall **C-weighted** sound level and the overall **A-weighted** sound level is equal to or greater than 10 dB.

Noise is any unwanted portion of **sound** due to its loudness, frequency, impulse tendency, variability of the **sound** level with time, and the circumstances surrounding the occurrence of the **sound**, such as time of day and location.

Penalties, when certain conditions require them, are added to the overall **A-weighted LAeq sound** level for comparison to the **permissible sound level**. For example, if a **tonal component** is present, a **penalty** of 5dB is added to the overall **$LAeq_{(1hour)}$**.

Permissible Sound Level (PSL) is the maximum **$LAeq_{(1\ hour)}$** and mean **L_{LM}** allowed over a **compliance period** in the **ambient** environment (outside a **receptor** or other specified out-of-doors location). See Appendix 1.

Qualified Person as it relates to **noise**, means one who has certified post-secondary education and/or professional training in **noise**, and a minimum of 5 years of experience in the field of **noise**, or as otherwise authorized by the Department. Where 'certified' means recognized education in acoustics, either as e.g., an acoustics degree, or where acoustics was taught as part of a degree (a module) that can be proven through the presentation of a certificate or transcript. Where 'professional' means either through a certified training course (proven through the presentation of a certificate) or in a professional setting under the supervision of a qualified person (CV or list of workplaces with details of the supervisor, projects, roles undertaken).

Rating level is calculated by logarithmically subtracting the **baseline LAeq** from the **ambient LAeq** and then adding any penalty for **tonal components**.

Receptor as it relates to this Guideline, is a building or structure including, but not limited to, a building or structure that contains one or more dwellings, an educational

facility, daycare/nursery, place of worship, hospital, or seniors' residence.

Slow Response is a standardized **sound** level meter response that helps to average out fluctuations on the meter's display. **Slow response** has a time constant of 1-second.

Sound is any pressure variation (in air, water or some other medium) that the human ear can detect. And, for clarity of legislated powers, **sound** is a '**substance**' as defined in the *Environment Act*.

Sound power level (SWL) is the **decibel** equivalent of the rate of energy (or power) emitted in the form of **noise**. The SWL is an inherent property of a **noise** source. The SWL is expressed as:

$$\text{Sound Power Level} = 10 \log_{10}\left(\frac{\text{Sound as Power}}{W_O} \right)$$

Where by international agreement, $W_o = 10^{-12}$ watts (W).

Sound pressure level (SPL) is the **decibel** equivalent of the pressure of **sound** waves, measured with a **sound** level meter.

Sound spectrum is the full range of **sound** frequencies. For the purposes of this guideline, the spectrum may be plotted as a graph of **sound** pressure peaks at 1/3 octaves (as set by the International Electrotechnical Commission in publication *IEC 61260*) between 20 Hz and 20,000 Hz (see the example in Appendix 5).

Specific noise is the **noise** level from a **target noise source**. It is calculated by logarithmically subtracting the **baseline noise** from the **ambient noise**.

Substance, defined in the *Environment Act*, includes any **sound**.

Target noise source is the **noise** source under investigation.

Tonal component is when a single frequency band is louder than the frequency bands around it. Tonal components are distinguishable from the overall sound level and can be heard as, for example, whistles, hums and screeches.

4.0 Guidelines

Where possible, **noise** levels should be measured under ideal conditions i.e., low to no wind (5m/s or less), no steady precipitation, and no excessive wave **noises** when near large water bodies. At higher wind speeds, wind and waves may cause **noise** that will interfere with the measurements. Under these circumstances, it is recommended that measurements be carried out over a period of time long enough to capture a varied sample of conditions. Analysis of **noise** data must be made with reference to the prevailing weather at the time of measurement. Weather, in particular the wind speed and direction, can have a significant impact on the **noise** levels experienced at receptors.

(a) Permissible Sound Levels (PSL)

(i) The criteria for **permissible sound levels** listed in Appendix 1 are expressed as one-hour **equivalent sound levels** (**$LAeq_{(1\ hour)}$ dBA**), except for impulsive **sounds** that are expressed as a logarithmic mean impulsive **sound** level (**L_{LM}**) of **dBAI** over the **compliance period**. The **permissible sound levels** are applicable to sound levels experienced at receptor locations.

(ii) Both permissible criteria, **$LAeq_{(1\ hour)}$** and **L_{LM}**, must be met.

(b) Geographic Area Classifications

(i) Rural

Rural residential areas are areas with a population of less than 1,000 and a population density of less than 400 persons per square kilometre.[1] Rural areas may also include agricultural, wilderness, recreation, or other areas dominated by natural **sounds.**

(ii) Urban residential

Urban residential areas include large urban, medium, and small population centres as described by Statistics Canada's *Population and dwelling counts: Canada and population centres*.[2] See Appendix 2. They have a population greater than 1,000 and a population density greater than 400 persons per square kilometre.

(iii) Industrial

An industrial area is an area of land that is predominantly occupied by a tenant or tenants undertaking industrial and/or commercial activities. This includes designated industrial parks, lands with industrial zoning, and other lands occupied by such things as factories, power plants, marine works, etcetera.

[1] Dictionary, Census of Population, 2016, "Population centre." https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/geo049a-eng.cfm.

[2] As updated from time-to-time https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=9810001101.

Industrial areas must not cause overnight **sound pressure levels** at **receptors** in residential areas to exceed the permissible sound levels for the residential area type. This includes when additional **sound** emitting sources are added to the industrial area.

(iv) Encroachment

In the case where the regulated activity existed first and receptors encroached on the regulated activity, Approval Holders only need to demonstrate that they would be in compliance with the PSLs at the point where the receptors were located at the time the approval was issued.

(c) Baseline Sound Levels

(i) The Department may require that a proponent have baseline **sound** levels measured by a **qualified person** using **Class 1** instrumentation in the area where an activity is proposed. The measured baseline **sound** levels may include existing broadband SPLs, an assessment of **tonal components**, and **impulsive noise**. Refer to Appendix 3 for **noise** measurement and reporting requirements.

(ii) The measurements in (c)(i) are used in combination with a model to determine the expected **comprehensive sound levels**. This includes **sound** from the contribution to the **noise** level and/or **tonal components** from the proposed activity at nearby **receptors**. **Comprehensive sound levels** should include the impact of impulsive noise events where such events occur regularly during activity operations.

(iii) Where the proposed activity is in an existing industrial area that is in or adjacent to an urban or rural residential area, the proponent may also be required to measure baseline **sound** levels and model **comprehensive sound levels**, **tonal components**, and **impulsive noise** at **receptors** in the residential areas.

(d) Tonal components

Tonal components may occur at any frequency, although not all **tonal components** are perceptible to the human ear. A sound can have a pronounced audible quality, such as a whine, screech, buzz, or hum, and may consequently be considered to be a **tonal component**. Monitoring for **tonal components** may be requested at the discretion of the Department.

Where a **tonal component** is suspected, and it occurs in the **low frequency** range, an analyst can use the two-step approach presented in (d) (ii) for certainty. An example of a test for **low frequency tonal components** is presented in Appendix 5.

Note that '**tonal components**' only refers to industrial noise. Where **tonal components** are present due to the natural environment, e.g., bird noises, no **penalty** is applied. Any **tonal components** that are identified in the spectra must be confirmed by an audio recording of the event and/or a site visit.

(i) Testing conditions

Because wind, waves and other natural sources may cause **low frequency noise** that will interfere with the measurements, it is recommended that measurements be carried out over a period of time long enough to capture a varied sample of conditions, including ideal conditions with low to no wind, no steady precipitation, and no excessive wave noises when near large water bodies.

(ii) Criteria to be measured

In the case that there is a need to test for unwanted **low frequency noise**, two criteria must be measured. First, both the **A-weighted** and **C-weighted sound pressure levels** are measured concurrently over the compliance periods. This may be achieved using two **class compliant**, co-located sound level meters, or a dual-channel sound level meter. The time-weighted average **dBA** value for the measured period is subtracted from the time-weighted **dBC** for the same period. A result of ≥20 **dB** indicates the presence of **low frequency noise**. That is:

dBC – **dBA** ≥ 20 **dB**

Secondly, the **slow-response**, **A-weighted, sound pressure levels (SPL)** of the spectrum of 1/3 octave band centre frequencies are measured and plotted on a **sound spectrum** (see the example in Appendix 3, figure 1). If any of the SPLs between and including 20 and 250 Hz is 10 **dBA** or more than the SPL of at least one of the adjacent frequency bands within two 1/3 octave bandwidths AND there is a minimum of a 5 **dBA** drop within two bandwidths on the opposite side of the band containing the tone, there is considered to be a **low frequency tonal component**.

(iii) **Penalty** for **tonal components**

A **penalty** for **tonal components** must be used in calculations to assess compliance with the **permissible sound levels** (Appendix 1) if a **tonal component** is identified. A 5 **dBA penalty** is added to the overall **LAeq** measured in the compliance period.

(e) Impulsive noise

(i) Using **Class 1** instrumentation to measure impulsive **sound pressure levels**, the number of **sound** impulses in a one-hour period during the day and evening (0700 to 2300 hrs) emitted by any one approved facility or source is limited according to peak **dBAI** and the geographic area classification. No overnight **impulsive noise** is permitted. See Appendix 6.

(ii) In addition to (e)(i), the logarithmic mean **impulsive sound level (L_{LM})**

of **dBAI** measured over the **compliance periods** listed in Appendix 1 must be met for the geographic area classification in which the **sound** is heard.

5.0 Implementation

(a) All Approval Holders must comply with these Guidelines immediately upon the date the Guidelines become effective with the following exceptions:

(i) All existing Approval Holders upon the date the Guidelines become effective, other than those issued an Approval under section 16(2)(e) of the Activities Designation Regulations (underground mines), and

(ii) All applicants issued an Approval after the date the Guidelines become effective but whose completed application was submitted before the effective date,

will have two years from the effective date of these Guidelines to be compliant with the Permissible Sound Levels and Impulsive Noise Limits set out in Sections 4(a) and 4(e) of these Guidelines. During the two-year transition period, Approval Holders must comply with the Permissible Sound Levels indicated below regardless of geographical area.

65 dBA 0700-1900 hours (Days)
60 dBA 1900-2300 hours (Evenings)
55 dBA 2300-0700 hours (Nights)

(b) Any existing Approval that requires an amendment after the effective date of these Guidelines will be updated to reference these Guidelines. Any Approval that is amended may be required to immediately comply with these Guidelines.

Appendices

Appendix 1: Permissible Sound Levels

The following table details the **permissible sound levels** to be used to assess compliance:

Table 1A: permissible sound levels.

Geographic classification	**LAeq$_{(1\ hour)}$ dBA** (including **$L_{LM(x\text{-}hrs)}$ dBAI)**		
	0700 to 1900 hrs	**1900 to 2300 hrs**	**2300 to 0700 hrs**
Rural	53	48	40
Urban residential	58	53	45
Industrial	65	60	55

The **permissible sound levels** are the maximum comprehensive sound levels that are permitted to be experienced at **receptor** locations i.e., when comparing against the permissible sound levels, maximum comprehensive sound levels must include baseline and target noise sources. **Baseline** sound levels must be measured; however, the **target noise** can be measured, or predicted through modelling.

To determine the maximum comprehensive sound levels, **baseline** and **target** noise levels can be added using the following equation:

$$\textbf{Comprehensive sound level} = 10\text{Log}_{10}(10^{(dB(1)/10)} + 10^{(dB(2)/10)})$$

Where: dB(1) is the baseline measurement
dB(2) is the measured or modelled **target noise**

Alternatively, the simple calculation shown in Table 1B can be used to determine the maximum **comprehensive sound level** - the adjustment is added to the higher noise level.

Once the maximum **comprehensive sound level** (**LAeq**$_{(1\ hour)}$) has been calculated, the **tonal penalty**, if applicable, must be added, before the comparison with the **permissible sound levels**.

It is the responsibility of the applicant to ensure that noise assessments comply with the **permissible sound levels** for the correct **geographic area classification** (see 4(b)).

Table 1B: simple calculation for adding two sound levels.

Difference between two sources (dB)	Decibel adjustment to be added to the highest sound level (dB)
0	3
1	2.5
2	2
3	2
4	1.5
5	1
6	1
7	1
8	0.5
9	0.5
10	0.5
>10	0

Proponents should use this methodology unless a high **baseline** noise level is confirmed through monitoring. Where the **baseline noise** level, without contributions from the **target noise source**, already exceeds the **permissible sound levels,** or is within -5 **dB** of the **permissible sound level**, the following alternative method may be used:

1. Measure the **LAeq**$_{(1\ hour)}$ and **LA$_{90}$** without contributions from the **target noise source** for each period of the day as specified in the table above. This is the **baseline noise LAeq**$_{(1\ hour)}$ and measured background **(LA$_{90}$)**.
2. Measure the **LAeq**$_{(1\ hour)}$ with contributions from the **target noise source**. This is the **ambient noise**.
3. Using the logarithmic method, subtract the **baseline LAeq**$_{(1\ hour)}$ from the **ambient LAeq**$_{(1\ hour)}$. This is the **specific noise**.
4. Identify any **tonal components** and add the **penalty** (see (e)). This is the **rating level**.
5. Compare the **rating level** with the **LA$_{90}$**. The **rating level** must not exceed the **LA$_{90}$** by >5 dB.

For example (fictional data):

A designated activity is located in an urban residential area. The approval holder has been asked to provide a noise impact assessment for the evening period which covers the end of the working day for the employees. The activity closes at 8pm and no machinery is left running overnight.

The **ambient noise** level was measured for 1 hour between 7pm and 8pm, and the **baseline noise** was measured from 8pm to 9pm. The **baseline noise** level was 48 **dBA** (measured as the **LAeq**$_{(1\ hour)}$). The ambient noise level was measured as 49 **dBA** and the **LA$_{90}$** was reported as 42.3 **dBA**. The 1/3 octave band analysis identified a tonal component at 200Hz. The **baseline noise** already meets the **permissible sound level** for the evening period in urban residential areas, so the alternative methodology was used.

Table 1C: alternative permissible sound level calculation method example 1.

Ambient (all noise) **LAeq**$_{(1\ hour)}$	**Baseline** (no **target noise**) **LAeq**$_{(1\ hour)}$	Measured background **LA$_{90}$**	**Specific Ambient-baseline** (log subtraction)	Tonal **penalty**	**Rating level**	Difference (**Rating level** to background)
dB	**dB**	**dB**	**dB**	**dB**	**dB**	**dB**
49.0	48.0	42.3	42.1	5.0	47.1	4.8

The assessment indicated that the designated activity was in compliance, as the difference between the **rating level** (plus tonal **penalty**) and the background level was less than 5dB.

In a second example, a designated activity wants to start operating during the evening period. The activity is located in a rural area and operates without complaints from nearby residents. **Baseline** and **ambient** noise measurements were taken. The **ambient** measurements were taken during the evening period with the activity running as a demonstration. No **tonal components** were observed in the 1/3 octave spectrum.

It was noted that the **baseline** noise level was within -5 **dB** of the **permissible sound level** for rural areas during the evening. The alternative method was therefore used.

Table 1D: alternative permissible sound level calculation method example 2.

Ambient (all noise) **LAeq**	**Baseline** (no **target noise**) **LAeq**	Measured background **LA$_{90}$**	**Specific Ambient-baseline** (log subtraction)	Tonal **penalty**	**Rating level**	Difference (**Rating level** to background)
dB	**dB**	**dB**	**dB**	**dB**	**dB**	**dB**
49.5	42.9	42.3	48.4	0	48.4	6.1

In this situation, the activity would not be in compliance if they operated in the evening as the **rating level** exceeds the background by 6.1 **dB**.

Appendix 2: Urban residential areas

Table 2A: index of urban residential areas (Stats Canada).

Geographic name	Urban residential area type	Map
Halifax	Large urban population centre	Halifax map
Sydney	Medium population centre	Sydney map
Amherst	Small population centre	Amherst map
Antigonish	Small population centre	Antigonish map
Berwick	Small population centre	Berwick map
Bridgewater	Small population centre	Bridgewater map
Brookside	Small population centre	Brookside map
Centreville	Small population centre	Centreville map
Chester	Small population centre	Chester map
Digby	Small population centre	Digby map
Enfield-Lantz	Small population centre	Enfield-Lantz map
Eskasoni	Small population centre	Eskasoni map
Glace Bay	Small population centre	Glace Bay map
Hantsport	Small population centre	Hantsport map
Hayes Subdivision	Small population centre	Hayes Subdivision map
Howie Centre	Small population centre	Howie Centre map
Indian Brook	Small population centre	Indian Brook map
Inverness	Small population centre	Inverness map
Kentville	Small population centre	Kentville map
Kingston-Greenwood	Small population centre	Kingston-Greenwood map
Lake Echo	Small population centre	Lake Echo map
Liverpool	Small population centre	Liverpool map
Lunenburg	Small population centre	Lunenburg map
Middleton	Small population centre	Middleton map
New Glasgow	Small population centre	New Glasgow map
New Waterford	Small population centre	New Waterford map
Pictou	Small population centre	Pictou map
Port Hawkesbury	Small population centre	Port Hawkesbury map
Port Williams	Small population centre	Port Williams map
Shelburne	Small population centre	Shelburne map
Springhill	Small population centre	Springhill map
Still Water Lake	Small population centre	Still Water Lake map
Sydney Mines	Small population centre	Sydney Mines map
Truro	Small population centre	Truro map
Windsor	Small population centre	Windsor map
Wolfville	Small population centre	Wolfville map
Yarmouth	Small population centre	Yarmouth map

Appendix 3: Environmental Noise Measurement and Reporting

Field Measurement

Noise measurement methodologies should principally be consistent, especially where multiple measurement events are required for a **specific noise** source. The methodology should be developed in accordance with ISO 1996:2016 Part 1 and ISO 1996:2017 Part 2 (as updated), and should include:

- The use of a **Class 1 sound** level meter that has a valid calibration certificate;
- The use of a microphone shield;
- Consistent position above ground; and
- A minimum of 3.5 m away from any reflecting façade.

The monitoring location must have a direct line of sight to the emitting **noise** source. It should be selected on the basis that the impact of other sources (e.g., road **noise**) is minimized. Where an assessment of **noise** levels without the **target noise** is required, and it is not possible to eliminate the **sound** from the **target noise source**, a location that is considered representative of the impacted location (e.g., upwind of the noise source) may be used as a surrogate. A justification for the use of this surrogate must be provided.

The duration of the monitoring period should reflect the requirements of the assessment - a minimum of 1 hour is required. For example, a longer period of monitoring may be required to establish baseline levels, whereas a shorter period of attended monitoring may be more appropriate for compliance purposes. The analyst should make a record of prevailing meteorology during the measurement period (wind speed and direction at a minimum), the ground surface (e.g., concrete, grass), the ground conditions (e.g., snow, wet, dry), and notable **noise** sources both on-site and off-site. The use of proformas may assist in recording site details and ensuring that the required information is collected. Measurements should be recorded in **dBA**. Additionally, the meter should be set to report **LAeq**$_{(1\ hour)}$, **LA$_{90}$**, **LA$_{Max}$**, frequency of occurrence for **impulsive noise** assessment, and 1/3 octave frequency bands.

Reporting

The **noise** measurement report must, at a minimum, include the following:

- The **sound** level meter(s) used, including the model, and most recent calibration certificate(s);
- The **noise** measurement methodology followed;

- A figure that clearly presents the location of the **noise** measurement locations, the facility property, nearby **receptors**, and the significant **noise** sources;
- The distance between the microphone(s) and the **noise** source(s);
- The prevailing meteorology during the measurement period (including wind speed and direction);
- The ground covering (e.g., grass, concrete etc.) and ground conditions (e.g., snow, wet, dry);
- On-site activities and operations during the **noise** measurement program;
- Any **sounds** that could interfere with the results;
- Any changes in the **noise** source(s) that could help to interpret the data; and
- A description of the number of hours or days used for measurement, and a rationale for why the reported **sound** levels can be considered representative for the purpose of monitoring.

The statistical analysis should, at a minimum, include:

- A table comparing the maximum **comprehensive sound levels** (**$LAeq_{(1\ hour)}$**) and any **impulsive levels** (**L_{LM}**) to the applicable **permissible sound levels** (Appendix 2) for each **compliance period**;
- A graph of the measured **LAeq sound** levels over the full duration of the measurement period that also shows the **permissible sound level** for each representative **compliance period;** and
- The measured **LA_{90}** for periods when the **target noise source** was not operating (where possible) and the concurrent wind speed was <5m/s.

The report may also include an assessment for **tonal components** (Appendix 5) and/**or impulsive noise** (Appendix 6) as required. Where there is any uncertainty regarding requirements for a **noise** assessment, please contact the Department. The report may also include an assessment of the impact of any applied mitigation.

Appendix 4: Noise Modelling

When required by the Department, **noise** modelling shall be used to predict what the **sound** levels will be from existing and/or proposed operations at the nearest impacted **receptors**. **'Receptor'** could also include vacant lots where appropriate zoning or permits to build such buildings and/or structures have been approved.

Assessments must consider the impacts of noise until the **target noise** meets the baseline level or the **permissible sound level**, whichever is higher.

The **noise** model selected must meet international standards (CONCAWE or ISO 9613). It also should incorporate the following parameters:

- Geometric spreading;
- Barrier effects;
- Atmospheric absorption;
- Ground attenuation; and,
- Specific wind speed/direction.

While consideration should be given to the following:

- Source identification;
- Source size and location;
- Isolation;
- **Sound power level** (SWL)-SPL spectrum data;
- Intermittency; and
- Mild downwind and/or temperature inversion conditions.

Noise modelling assessments must be submitted to the Department and should include, but not be limited to, details regarding the model used, the source directivity considered, the ground absorption conditions, meteorological parameters, terrain parameters, reflection parameters, and **SWL** calculations and assumptions. The **noise** modelling assessment report must also, at minimum, present the results in the following manner:

- A table comparing the maximum predicted comprehensive sound levels (**$L_{Aeq(1\ hour)}$**) and any impulsive levels (**L_{LM}**) to the applicable **permissible sound levels** (Appendix 1) for each **compliance period**;
- Isopleth figures showing the maximum predicted **LAeq** and **L_{LM}** values for each **compliance period** for the surrounding area. Isopleth figures must clearly indicate the project boundary and location of **receptors**; and
- If exceedances are predicted, the assessment must include the use of appropriate mitigation and re-modelled to demonstrate compliance.

Where there is any uncertainty regarding the requirements for a **noise** modelling assessment, please contact the Department.

Appendix 5: Example of a test for tonal components

In this hypothetical example for an urban residential area, the mean one-hour **sound pressure level** (SPL) measured at 250 Hz in the 1/3 octave band centred **sound spectrum** is 50 **dBA**. The SPL measured within two adjacent bands on one side, at 160 Hz, is greater than a 10 **dBA** difference, and there is a greater than 5 **dBA** drop within two frequency bands on the adjacent side, 44 **dBA** at 400 Hz, so a pure tone is present at 250 Hz. Note that there is also a **tonal component** at 630 Hz, but this is not considered low frequency (i.e., greater than 250 Hz).

Also, for the sake of example, consider that the mean one-hour **LAeq**$_{(1\ hour)}$ SPL during the **compliance period** hours of 2300 to 0700 hrs is 42 **dBA** and the mean **LCeq**$_{(1\ hour)}$ SPL measured for the same period by a co-located sound level meter is 65 **dBC**. Then, 65 **dBC** – 42 **dBA** = 23 **dB**.

Both criteria for **low frequency noise** and tone are met so a 5 **dBA penalty** is added to the **LAeq**$_{(1\ hour)}$. This gives 42 **dBA** + 5 **dBA** = 47 **dBA** and this exceeds the PSL for the **compliance period** of 45 **dBA**.

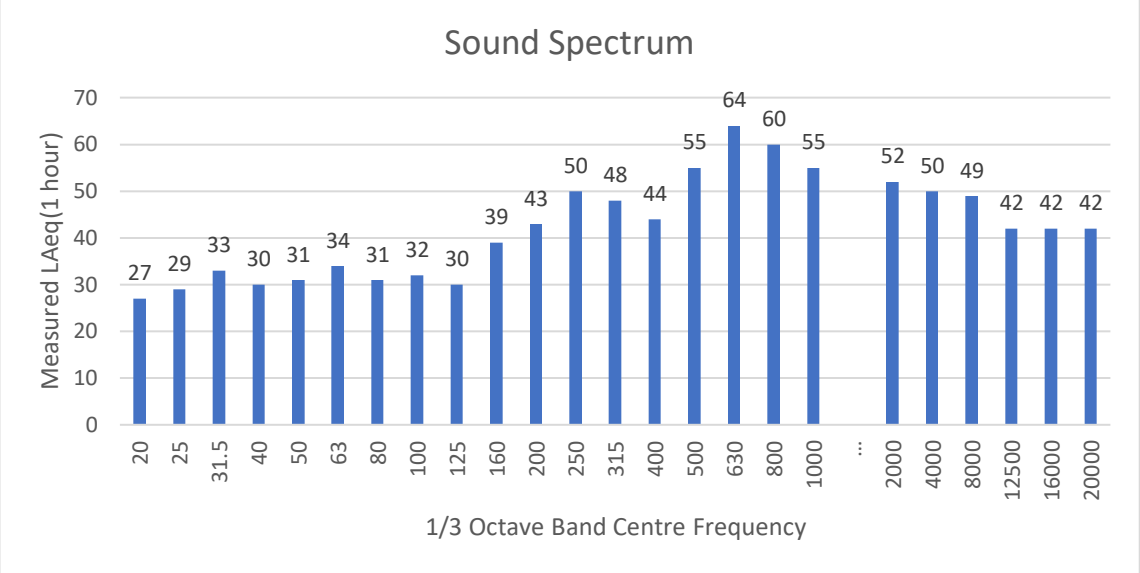

Figure 1. Example of a 1/3 octave band centred **sound spectrum** (fictional data).

Appendix 6: Number of permitted impulsive noises.

Table 6A: permissible impulsive noises by decibel level and geographic area.

		dBAI		
	Number of pulses in a period of one-hour	**Rural**	**Urban Residential**	**Industrial**
0700 to 2300 hrs*	9 or more	45	50	60
	7 to 8	50	55	65
	5 to 6	55	60	70
	4	60	65	75
	3	65	70	80
	2	70	75	85
	1	71-128	76-128	86-128

*Zero permissible pulses during the hours 2300 to 0700 hrs.

Impulsive noises must not exceed 128 dBA at any time.