Directive 038

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Noise Control

Contents

1 Introduction

1.1 Purpose of This Directive

Directive 038: Noise Control states the requirements for noise control as they apply to all operations and facilities under the jurisdiction of the Alberta Energy Regulator (AER). The directive also provides background information and describes an approach to deal with noise problems.

The requirements address environmental noise, not health-related impacts, such as noise-induced hearing loss. Non-energy facility noise issues are the jurisdiction of Alberta Environment and Protected Areas or the local municipality.

1.2 Requirements

Following AER requirements is mandatory for the responsible duty holder as specified in legislation (e.g., licensee, operator, company, applicant, approval holder, or permit holder). The term “must” indicates a requirement, and terms such as “should,” “recommends,” and “expects” indicate a recommended practice.

Each AER requirement that is unique to this directive is numbered.

Information on compliance and enforcement can be found on the AER website.

1.3 What’s New in This Edition

The definition of “emergency” in this directive has been revised.

1.4 Need for Balance

This directive attempts to take a balanced viewpoint by considering the interests of both the nearby residents and the licensee. It does not guarantee that a resident will not hear noises from a facility; rather it aims to not adversely affect indoor noise levels for residents near a facility. The directive sets permissible sound levels (PSLs) for outdoor noise, taking into consideration that the attenuation of noise through the walls of a dwelling should decrease the indoor sound levels to where normal sleep patterns are not disturbed.

1.5 Receptor Based

The directive considers noise at the point of the receptor, rather than at the property line. Criteria based on property line measurements were considered to be problematic for several reasons:

- They might be too restrictive in rural settings since a natural buffer often exists between operating facilities and any occupied dwellings.
- It is difficult to select an appropriate maximum noise level that could be applied uniformly.

- More land might be "sterilized" from other development because of the need for industry to purchase land to act as a buffer, extending the property line from the facility.
- Due to the nature of many elevated sources of noise associated with industrial facilities, measurements from property lines may not accurately reflect the noise levels that would exist at a dwelling.

Measuring noise levels at the dwelling allows a licensee to take maximum advantage of the normally substantial distance in rural areas between a facility and any dwellings. The only exception is for facilities in remote areas where a receptor is not present. In such cases a PSL of 40 decibels A-weighted energy level equivalent (dBA Leq) nighttime must be met at 1.5 kilometres (km) from the facility fence line.

1.6 Industrial Noise and Domestic Animals and Wildlife

Landowners and residents often express concern about the impact of industrial noise on domestic animals and wildlife. While not the basis for these requirements, the AER continues to examine peer-reviewed scientific literature and has concluded to date that typical industrial noise regulated under its jurisdiction does not significantly impact the physiology and habituation patterns of animals over the long term. The literature does suggest that animals might temporarily avoid an area until they become familiar with or acclimatized to industrial noise.

1.7 Best Practices

Licensees are encouraged to adopt and incorporate a best practice approach to noise management into their maintenance and operating procedures. This may include such things as taking regular fence line measurements to determine if there are any significant changes to sound emanating from the facility and improving notification measures to neighbours of a planned noisy event. Licensees wishing more information on a best practice approach may contact the AER.

1.8 Scope

This directive applies to developments permitted, licensed, or approved under the *Oil and Gas Conservation Act*, *Coal Conservation Act*, *Oil Sands Conservation Act*, *Geothermal Resource Development Act*, *Mineral Resource Development Act*, or *Pipeline Act*.

1.8.1 Noise Control at Well Sites or Facility Operations

For drilling and servicing activities, the well licensee is responsible for noise control at the well site. Compliance regarding drilling and servicing activity noise is evaluated on a complaint basis only and is initially assessed by the local AER field centre.

While noise impacts from facility-related heavy truck traffic and vibration impacts from facility operations are not specifically addressed in this directive, receipt of complaint with regard to these sources may require corrective action from the licensee. The AER acknowledges the special nature of these sources and is prepared to consider these on a site-specific basis. A licensee is expected to take every reasonable measure to avoid or minimize the impacts of heavy truck traffic and vibration.

If a valid noise complaint is received for a facility, compliance with the directive is established if a comprehensive sound level (CSL) survey indicates that the cumulative facility contribution is equal to or less than the PSL. In unique situations where a comprehensive sound survey is not practical, the AER may approve a noise management plan.

If a facility is found to be noncompliant, the licensee is given the time stated in the enforcement document to undertake corrective action. This includes time for sound monitoring, analysis, evaluation, and equipment procurement and installation.

1) The licensee must be in communication with the complainant through all phases of corrective action.

1.8.2 Development of Dwellings

The receptor-oriented approach does not protect a licensee against local landowners, residents, or developers wanting to build a dwelling on a location near a facility where the PSL (as determined by section 2) may be exceeded. Therefore, licensees are advised to consider the magnitude of this risk when choosing sites, designing facilities, and negotiating leases. Licensees are strongly encouraged to communicate with nearby residents to identify imminent developments. Applicants’ or licensees’ representatives are then expected to work proactively to minimize potential impacts on new developments.

2) Licensees must communicate existing noise levels (using existing noise survey data or modelling data extrapolated to the proposed building site) to any landowners, residents, and developers proposing dwellings near a facility. In all cases, the licensee must keep documentation of communication between the licensee and landowners, residents, and developers.

In cases where landowners, residents, or developers build dwellings near an existing facility and ignore the obvious noise impact, the PSL will be the existing noise level at the new dwelling coming from the facility. The AER expects a licensee to be prepared to comply expeditiously with the requirements of this directive once it becomes aware that new developments resulted in the facility exceeding the PSL.

2 Determining Sound Levels and Adjustments

2.1 Permissible Sound Level

3) New facilities must meet a PSL of 40 dBA Leq (nighttime) at 1.5 km from the facility fence line if there are no closer dwellings.

If there are dwellings within 1.5 km of the facility fence line, the PSL is determined as described below. Cases where the development of dwellings occurs after a facility has begun operations are covered in section 1.8.2.

This section sets out the tables used to determine PSLs, basic sound levels (BSLs), and adjustments.

The PSL is generally derived from a base value (the BSL), which includes a 5 dBA allowance to the ambient sound level plus adjustments intended to more accurately reflect specific aspects of the facility and the environment.

The PSL is determined for the nearest or most impacted dwelling and is assigned to that dwelling unit.

The predicted facility noise levels plus average rural ambient levels are compared to the PSL in a noise impact assessment (NIA) (section 3.3). The actual isolated facility noise levels are compared to the PSL for complaint situations (section 5.1).

Because most noise concerns for residents occur during the summer months, the PSL definition is based on summertime conditions. If complaints do occur in the winter, the PSL may be modified to reflect site-specific winter conditions after consultation with the AER.

The PSL is calculated as follows:

Permissible sound level	=	Basic sound level (section 2.1.1)	+	Class A adjustment (table 2)	+	Class B adjustment (table 3)

One exception to the method for PSL determination is for pre-1988 facilities that are undergoing an expansion or modification (see section 2.2).

The PSLs do not apply in emergency situations.

An emergency means a present or imminent event outside the scope of normal operations that requires prompt coordination of resources to protect people's health, safety, or welfare or limit damage to property and the environment. Planned maintenance or operational events (e.g., blowdowns, catalyst changes) may be considered temporary activities and thus qualify for a Class B adjustment. Prior to such events, licensees should inform nearby residents of the potential for increased sound levels and should attempt to schedule the events during daytime hours to reduce the noise impact on nearby residents.

2.1.1 Basic Sound Level

2.1.1.1 Nighttime Basic Sound Level

Nighttime BSLs are determined from table 1. The average rural ambient sound level in Alberta is about 35 dBA Leq at night. Therefore, the BSL is determined to be 40 dBA Leq (5 dBA Leq above ambient) to generate the minimum PSL. Moving down each column in table 1, an adjustment is made to the BSL for proximity to transportation noise sources. Moving across each row, an adjustment to the BSL is made for higher population density.

Table 1. Basic sound levels for nighttime

	Dwelling unit density per quarter section of land		
Proximity to transportation	**1 – 8 dwellings 10:00 p.m. – 7:00 a.m. (dBA Leq)**	**9 – 160 dwellings 10:00 p.m. – 7:00 a.m. (dBA Leq)**	**>160 dwellings 10:00 p.m. – 7:00 a.m. (dBA Leq)**
Category 1	40	43	46
Category 2	45	48	51
Category 3	50	53	56

Notes:

Category 1—dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.

Category 2—dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.

Category 3—dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers.

Density per quarter section—refers to a quarter section with the affected dwelling at the centre (a 451 m radius). For quarter sections with various land uses or with mixed densities, the density chosen is the average for the area under consideration.

See appendix 1 for more definitions.

2.1.1.2 Daytime Basic Sound Level

The daytime BSL recognizes that daytime ambient sound levels are commonly 10 dBA Leq higher than nighttime levels and that nighttime noise disturbances are generally considered less acceptable. The daytime period is 7:00 a.m. to 10:00 p.m.

2.1.2 Adjustments to Basic Sound Level

2.1.2.1 Class A Adjustments

Class A adjustments are based on the nature of the activity and/or the actual ambient sound level in an area.

4) Technical verification must be supplied to use any of the adjustments to the BSL.

More than one Class A adjustment may be claimed for permanent facilities if applicable to a maximum of 10 dBA Leq.

Table 2. Class A adjustments

Class	Reason for adjustment	Value (dBA Leq)
A1	Seasonal adjustment (wintertime conditions)	0 to +5
A2	Ambient monitoring adjustment	−10 to +10

Note: Class A adjustment = Sum of A1 and A2 (as applicable), but not to exceed a maximum of 10 dBA Leq.

A1—Seasonal Adjustment

The PSL determination is for summertime conditions. Therefore, a seasonal adjustment may be allowed for wintertime complaints.

5) The licensee must not add this seasonal adjustment when determining the PSL for design purposes. The adjustment may only be used during the complaint process (section 4) and prior approval from the AER must be obtained.

After consultation with and approval from the AER, the PSL may be modified to reflect site-specific conditions for a wintertime complaint. If it is demonstrated that the facility may affect a winter recreation area where a quiet environment is a key aspect, the seasonal adjustment might not be allowed.

A2—Ambient Monitoring Adjustment

The ambient sound level (ASL) is the average sound environment in a given area without the contribution of any energy-related industry. An adjustment for an incremental change to the BSL is applicable only when BSLs (table 1) are thought not to be representative of the actual sound environment and when ASLs have been measured. The only two cases where it may be necessary to determine the ASL are as follows:

- areas considered to be pristine (defined in appendix 1), and
- areas with non-energy industrial activity that would impact the background noise levels.

6) In either case, the licensee must obtain prior approval from the AER to determine if an ambient sound adjustment is applicable.

Licensees may choose to conduct a background noise survey to determine the total noise levels that currently exist in an area for information purposes. The background noise level would include all current noise sources (such as energy-related industry, non-energy industry, transportation).

An ambient sound monitoring survey consists of a continuous sound monitoring survey for an extended period of time, with measured ASLs for the daytime and nighttime periods, that is conducted 15 m from the nearest or most impacted dwelling unit and under representative conditions. The 15 m requirement may be altered if it is physically impossible or acoustically illogical. Another measurement location may be chosen if the affected dwelling is not an appropriate location.

7) An ambient sound survey must be conducted without any energy-related industrial components.

See figure 1 to determine the appropriate adjustment value, A2, which will be added to any other applicable Class A adjustment factors.

To use figure 1:

- Determine the difference between the BSL (section 2.1.1) for the appropriate dwelling density and transportation proximity and the measured ASL to the nearest whole number.
- Look up this difference on the *x* axis of figure 1.
- Move up on the figure until the plotted line is intersected.
- Move left on the figure and read off the applicable A2 adjustment factor; it may be positive or negative.
- Add this adjustment factor to any other applicable Class A adjustment factors to arrive at the Class A adjustment. Note that if the sign of A2 is negative, you will be adding a negative number to arrive at the Class A adjustment.

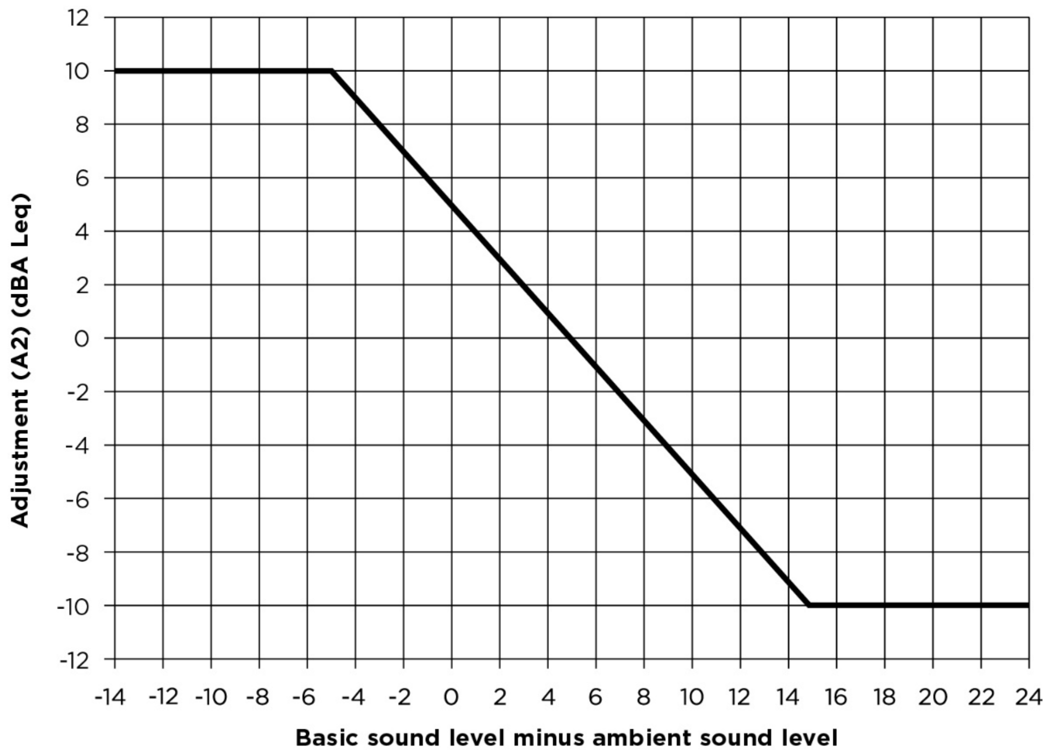


Figure 1. Ambient monitoring adjustment, A2

2.1.2.2 Class B Adjustment

These values are intended to permit adjustments to the BSLs based upon people's responses to temporary noise generating activities. These are activities lasting 60 days or less and occur no more than once every 12 months. If it is known that an activity will only be of a temporary duration, there may be some additional tolerance of it.

8) In order to use this adjustment, the licensee must fully inform the potentially impacted residents of the duration and character of the noise.

Table 3. Class B adjustments

Class	Duration of activity (days)	Value (dBA Leq)
B1	1	+15
B2	7	+10
B3	≤60	+5
B4	>60	0

2.1.3 Special Cases

The AER recognizes that there will be situations that do not fit into the categories in the directive. These individual cases will be reviewed on a site-specific basis.

2.1.3.1 Special Areas

Under special circumstances, the PSLs calculated using this directive may need to be reviewed. A higher or lower noise emission from a resource facility may be deemed appropriate in such exceptional circumstances. The AER may designate areas that meet these exceptional circumstances.

One such exception is Alberta's Industrial Heartland (AIH) in the Fort Saskatchewan region. The AIH comprises about 40 industrial facilities, of which about half are regulated by the AER, while the remaining industrial facilities do not fall under AER jurisdiction and therefore are not required to meet AER requirements. The PSLs for the AIH are based in part on ASL data dating back as far as 1980, when there were few AER-regulated facilities. New and existing licensees considering expansion are required to comply with this directive and should consult with the Northeast Capital Industrial Association office, the local municipal noise bylaw, or the AER for information relevant in determining compliance for the area.

2.2 PSL Determination for Pre-1988 Facilities

Facilities constructed and in operation before October 1988 are considered to be deferred facilities, meaning they do not have to demonstrate compliance with the PSL calculated using section 2.1 in the absence of a complaint.

This does not exempt them from the requirements of this directive but does recognize that they were potentially designed without the same consideration for noise as facilities approved after the issuance of the first AER noise requirements.

Deferred facilities without any noise complaints registered against them with the AER are considered to meet community noise tolerance levels. This existing noise level is considered to be the site-specific PSL for the facility if it is currently above the PSL as calculated using section 2.1.

9) If the facility does not meet the appropriate site-specific PSL, the licensee must bring the facility into compliance.

However, deferred facilities are encouraged to meet the section 2.1 PSL.

In cases where a valid complaint has been registered, the PSL is determined by applying the BSLs and adjustments (section 2.1).

If a licensee is modifying or expanding a deferred facility, the pre-expansion or premodification PSL will become the PSL for the expanded or modified facility if it is currently above the PSL as calculated using section 2.1.

10) The existing noise sources at the facility must be reduced in acoustic output to make room for the introduction of new noise sources so that there is no net increase in noise emitted from the facility.

3 Noise Impact Assessments

3.1 Intent and Objective

11) Licensees must conduct an NIA to ensure that possible noise impacts are considered before a facility is constructed or in operation.

It is suggested that a facility be designed with a suitable margin of safety (for example, 5 dBA Leq below the PSL) to cover absolute worst-case situations, possible low frequency noise (LFN), and inability of noise mitigation measures to meet performance levels. The cost to retrofit may be significantly more than if noise mitigation measures are incorporated into the design of a facility.

An NIA predicts what the sound level from the proposed facility will be at the nearest or most impacted permanently or seasonally occupied dwelling. Best practical technology (accounting for cost versus benefit) should be considered to minimize the potential noise impact to existing dwellings.

12) The facility must be modelled under operating conditions.

For example, if the compressor is modelled to operate with doors and windows closed, the facility must operate under those conditions to meet the PSL. Licensees are encouraged to consider the potential for future development of dwellings by local landowners, residents, or developers.

Licensees moving into an area with nearby residents should establish good relationships by discussing noise matters with area residents during the design, construction, and operating phases of an energy facility.

13) If a valid complaint is registered after the facility is in operation, the licensee must meet the PSL as determined by this directive.

It is in the licensee’s best interest to get as accurate a predicted sound level as possible. Compliance determination is based on measurements.

14) An applicant planning a facility in an area where there is already an energy industry presence must ensure that its facility will not cause the overall sound levels to exceed the PSL or, if the existing noise levels are acceptable to residents, even though the noise levels may be higher than the PSL (only for deferred facilities), that its facility will not cause an increase in overall sound levels.

The applicant may wish to discuss the proposed project with adjacent licensees to examine potential sound attenuation measures that are both effective and economical. For example, it may be more cost effective to install silencers on existing equipment rather than design additional sound attenuation measures into the proposed facility.

3.1.1 Construction Noise

While *Directive 038* is not applicable to construction noise, licensees should attempt to take the following reasonable mitigating measures to reduce the impact on nearby dwellings of construction noise from new facilities or modifications to existing facilities. Licensees should

- conduct construction activity between the hours of 07:00 a.m. and 10:00 p.m. to reduce the potential impact of construction noise;
- advise nearby residents of significant noise-causing activities and schedule these events to reduce disruption to them;
- ensure that all internal combustion engines are fitted with appropriate muffler systems;
- take advantage of acoustical screening from existing on-site buildings to shield dwellings from construction equipment noise; and
- be familiar with the requirements or best practices of any other applicable jurisdictions (e.g., municipal bylaws).

Should a valid complaint be made during construction, the licensee is expected to respond expeditiously and take appropriate action to ensure that the issue has been managed responsibly.

3.2 NIA Required

15) An applicant must complete an NIA before submitting an application for any new facility or for modifications to existing facilities where there is a reasonable expectation of changes in noise source. The AER may also require an NIA for a facility where the AER thinks one is warranted.

For facilities to which *Directive 056: Energy Development Applications and Schedules* applies, the NIA does not have to be included with the facility licence application if the analysis indicates compliance with the PSL as determined by this directive.

16) However, the applicant must keep a copy of the NIA and have it available in case of audit.

17) If the NIA indicates noncompliance with the PSL, the applicant must consider further attenuation measures. If such measures are not practical, the applicant must include the completed NIA with the application, along with reasons why the measures proposed to reduce the impacts are not practical.

See *Directive 056* with regard to submitting a nonroutine facility licence or licence amendment application. If the applicant is unsure of the requirements for an NIA, the AER should be contacted.

For other facilities, see the appropriate application requirements.

Drilling and servicing rigs fall into the temporary facility category even if they are expected to be at a location more than 60 days. Temporary activities generally do not require an NIA. The licensee is responsible for noise control.

3.3 Comparing Predicted Noise Level to the PSL

The predicted facility sound pressure level is added to the average rural ASL using the methodology in Appendix 2. The combined facility and ambient noise level is compared to the PSL. The average rural ASL is 5 dBA less than the BSL (table 1).

3.4 Cumulative Noise Environment

The PSL is determined using the methodology described in section 2.

18) The cumulative noise level of the existing and proposed facilities must not exceed the PSL.

In areas with established energy facilities, the licensee may want to discuss the proposed project with adjacent licensees, as the PSL may already be calculated for the nearby dwellings (a dwelling can only have a single PSL).

3.5 Sound Level Prediction Methodology

19) Licensees must follow and use appropriate acoustical engineering practices, equipment, and techniques when measuring or modelling sound levels. The proposed measurement approach should meet the requirements set out in this section. All documentation must be available for AER audits.

The simplified 6 dBA loss per doubling of distance is an estimate commonly used. While such simplified or other informal calculations are generally not recommended, they are acceptable under limited circumstances (see appendix 2 for conditions under which the estimate may be used). In cases where the simplified approach is not acceptable, an acoustical engineering consultant should be contacted.

3.5.1 Noise Models

Differences can occur in predicted noise levels from noise modelling depending on such factors as the noise propagation algorithm used, input parameters, and sound pressure level calculations. Acoustic modellers have the flexibility to choose the appropriate model. However, modellers should be aware of the limitations of the models they use.

20) The model must incorporate the following parameters:

   a) geometric spreading,

   b) barrier effects,

   c) atmospheric absorption,

   d) ground attenuation, and

   e) specific wind speed and direction.

Consideration should be given to

- source identification
  - source size and location
  - isolation
  - sound power level (PWL)
  - sound pressure level spectrum data
  - intermittency
- mild downwind and/or temperature inversion conditions

21) The following must be used in modelling summertime conditions for an acceptable NIA:

   a) wind speed: 5.0 to 7.5 km per hour (km/hr)

   b) wind direction: from the facility to the receptor(s)

   c) temperature: 0 to 25 degrees Celsius

   d) relative humidity: 70 to 90 per cent

   e) topography and ground cover: consistent with site conditions

22) While the AER does not endorse any specific international standard or computer noise modelling software program, models must use international standards (CONCAWE or ISO 9613).

23) Concerns expressed by local residents must be used to justify computer noise modelling parameters, such that “representative conditions” are the condition being modelled. Specifically,

   a) prediction models must be field-calibrated when practical;

   b) frequency specific predictions must be performed; and

   c) operational conditions must be quantified.

3.5.2 Low Frequency Noise Considerations

LFN may be a problem in some situations where the dBA value is satisfactory, but the concern is a dominant low frequency that creates a great deal of annoyance. Provided that data are available, C-weighted sound pressure level (dBC) minus the A-weighted sound pressure level (dBA) should be made in the noise modelling of new facilities or facility modifications or expansions to minimize the potential for LFN concerns. See section 4.1.1 for details on LFN determination and adjustment to CSL results.

3.6 Reporting Requirements for an Acceptable NIA

24) As part of a facility application, the licensee must show that the facility meets the requirements in this directive. It must also keep all supporting information available

   a) in case the AER conducts an audit on the facility application, and

   b) for reference if a valid noise complaint is registered.

25) An acceptable NIA must include the following information:

   a) PSL

      Identify the PSL and the direction and distance to the nearest or most impacted dwelling(s). This includes all details on how the PSL was calculated and any adjustments claimed.

   b) Sound Source Identification

      Identify major sources of noise (such as cooler fans, exhaust noise, and pump noise) from the facility and their associated sound power/pressure levels.

      Indicate whether the sound data are from vendors, field measurements, theoretical estimates, etc. Note that use of any theoretical data or extrapolation techniques can lead to inaccuracies and therefore is less reliable than actual field measurements made once the equipment is in place.

c) Operating Conditions

When using manufacturer’s data for expected performance, it may be necessary to modify the data to account for actual operating conditions (indicate design conditions, such as operating with open or closed compressor building windows and doors).

d) Noise Model Parameters

The following should be clearly stated within the NIA, so that if the AER audits a facility and requests the NIA, the assessment can be understood:

- type of model used (models or hand calculations may be used to obtain the predicted sound level,
- standards selected,
- source directivity considerations,
- ground absorption conditions,
- meteorological parameters,
- terrain parameters selected,
- reflection parameters, and
- any adjustments made. (Documentation of power level calculation assumptions made must be provided, e.g., source size considerations).

26) If sound pressure levels are determined using estimates as outlined in appendix 2, the NIA must clearly show that the conditions in appendix 2 are met.

a) Predicted Sound Level/Compliance Determination

Identify what the predicted *overall* (cumulative) sound level at the nearest or most impacted dwelling will be. Normally only the nighttime sound level is necessary, as it will often not change from daytime to nighttime. But if there are differences between day and night operations, both levels must be calculated. Indicate whether the facility is in compliance with requirements.

b) Compliance Determination/Attenuation Measures

If the predicted sound level indicates noncompliance with this directive, identify attenuation measures that the licensee is committing to and implementing for compliance.

If the predicted sound level indicates noncompliance with this directive and further attenuation measures are not practical, the NIA must be included with the application, along with reasons why the measures proposed to reduce the impacts are not practical.

c) Analyst's Information

Provide the name and contact information for the person conducting the NIA.

A Noise Impact Assessment form to assist in conducting an NIA is available from the *Directive 038* landing page. It includes the major types of information that must be included in an NIA. Questions regarding NIAs may be directed to the AER.

4 Noise Complaint Investigations

27) Licensees must in a timely manner make every reasonable attempt to resolve any noise-related complaint. When investigating a noise complaint, licensees must first attempt to resolve the issue through direct contact with the complainant to understand the concerns and establish a dialogue.

The AER may be contacted to mediate or initiate an alternative dispute resolution process respecting a valid noise complaint. Should a successful resolution not be achieved through mediation, a request may be made to review the licence under the appropriate sections of the *Responsible Energy Development Act*.

When a valid noise complaint is registered with the local AER field centre, the AER will begin its investigation. If a facility is found to be in noncompliance, the AER field centre will proceed with compliance assurance activities, as outlined in section 5. Once a facility has been determined to be in compliance, the AER investigation will be closed. Also, should conditions at the facility change in the future, a new valid complaint may be registered.

Compliance regarding drilling and servicing activity noise is evaluated on a complaint basis only and is initially assessed by the local AER field centre. Licensees are expected to act immediately to remedy any problems.

28) The complaint must be resolved before finishing the drilling and servicing activity. If the valid complaint cannot be resolved, the licensee may be required to submit a CSL survey to determine compliance.

A noise complaint cannot be registered against a deferred facility as a result of gathering noise emission data as part of an application for modification.

4.1 Investigation Procedures

29) Once the licensee is aware of a complaint, the licensee must make direct contact with the complainant to understand the concerns and to establish a dialogue to set reasonable expectations and a timeframe for action to resolve the issue. In doing so, the licensee must carefully explain the requirements of this directive and clearly outline the process, including timelines it intends to follow in addressing the matter.

30) If a CSL survey is to be performed, the licensee must complete the Noise Complaint Investigation form (available from the *Directive 038* landing page) to determine the representative conditions that exist when noise is affecting the resident. For example, if a facility was modelled in the NIA to operate with doors and windows closed, this is a condition of operation to ensure that the PSL is met.

In Part 1 of the Noise Complaint Investigation form, the licensee enters information about the quality and characterization of the noise from the residents to help determine the source of the noise. This part also examines the weather and ground cover conditions that exist when the noise is most annoying to the residents. With this information, the licensee, or its representative, can establish the typical representative conditions that exist under which sound level monitoring should take place. If the complainant has highlighted specific weather conditions, facility operating conditions, or seasons, the monitoring should take place under these representative conditions.

Representative conditions do not constitute absolute worst-case conditions or the exact conditions the complainant has highlighted if those conditions are not easily duplicated. In order to expedite complaint resolution, sound measurements should be conducted at the earliest opportunity when sound propagation towards the impacted dwelling is likely and representative conditions might exist. An extended-duration survey (more than 24 hours) may be considered to ensure that representative conditions have been met (see section 4.1.2). The licensee may consult the local AER field centre for help in establishing criteria for determining when favourable conditions exist.

Part 2 of the Noise Complaint Investigation form, the event log, is designed for use by the residents concerned about the noise. The residents should enter details about the noise when it is annoying to them. The event log can then be used by the licensee to further pinpoint the source of the noise or the representative conditions needed to conduct a CSL survey.

31) CSL surveys must encompass a representative portion of the time of day or night on days when the noise causing the complaints typically occurs. The surveys should be conducted at the first opportunity when the representative conditions can be reasonably met.

32) Licensees must provide a copy of the completed Noise Complaint Investigation form to the complainant and include a copy in any CSL reports to demonstrate that the representative conditions were met.

33) If the complainant does not complete Part 2 of the form, the licensee must use best judgement to determine representative conditions. If the Noise Complaint Investigation form is not completed, an explanation must be provided in the report for the absence of the form and for how the representative conditions were determined.

The monitoring period for a CSL survey may vary from 9 to 24 hours or cover multiple days, depending on the type, time, and duration of the noise.

34) There must be at least 3 hours of acceptable data (after isolation analysis) for the nighttime period and for the daytime period (if required) for the survey to be considered valid.

35) The measurements are to be conducted 15 m from the complainant's dwelling in the direction of the noise source. The 15 m requirement may be altered if it is physically impossible or acoustically illogical.

36) If the PSL was established for deferred facilities using modelling results, the outcome of the CSL must be adjusted if necessary, taking into account the input conditions used to generate the modelled results. For example, if the PSL was determined by inputting summer, calm conditions in the model, the CSL must be measured under similar seasonal and meteorological conditions.

When the measured CSL exceeds the PSL but noise from the facility and its related activities is not considered to be responsible for the exceedance, a further assessment using an appropriate isolation analysis (section 4.3.2) technique to separate the facility noise contribution from the measured CSL may be carried out. This will, in effect, separate noises not related to the facility. This isolated facility contribution can then be compared to the PSL for compliance.

4.1.1 Low Frequency Noise

A-weighting measurements typically discount the lower frequencies; therefore, LFN may be a problem in some situations where the dBA value is satisfactory, but the concern is a dominant low frequency that increases annoyance levels at nearby dwellings. Due to the complexity of determining LFN, this is a specialized investigation. The procedure outlined below and in appendix 3 will be done in specific response to an LFN complaint identified through the complaint investigation process and as a second-stage investigation.

The Noise Complaint Investigation form, available on the *Directive 038* landing page, should help to identify if there is a potential for LFN.

37) If the potential for LFN does exist, measurements must be conducted in both C- and A-weighted networks concurrently. Measurements may be made using two concurrently monitoring sound level meters, a dual-channel capable sound level meter, or other equipment capable of obtaining both the C- and A-weighting sound levels simultaneously.

An LFN complaint condition may exist when

- the isolated (i.e., nonfacility noise, such as wind noise, has been removed) time-weighted average dBC – dBA value for the measured day- or nighttime period is equal to or greater than 20 dB, and
- a clear tonal component exists at a frequency below 250 hertz (Hz).

38) If LFN is confirmed to exist, a 5 dBA Leq penalty must be added to the appropriate CSL results. If this value exceeds the PSL, the licensee will be required to identify the potential source and outline an action plan to address the issue in a timely way.

Once LFN noise control measures have been installed, a follow-up CSL survey and complaint interview will be done to confirm that the LFN condition has successfully been addressed.

39) In all cases where LFN may be a consideration, measurement of local wind conditions must be taken throughout the assessment period.

Wind generates high levels of low frequency (and infrasonic) sound energy, which can mask or confuse the assessment for industrial LFN. Measurements of LFN should only be taken when atmospheric conditions are favourable for accurate measurement (see table 4 and appendix 3).

4.1.1.1 Determination of Tonal Component

The AER has defined the following conditions as indicating the presence of a low frequency pure tone in the noise measured at a receiver location. For the ⅓ octave frequency bands of 250 Hz or below,

- the linear sound level of one band is 10 dB or more above at least one of the adjacent bands within two ⅓ octave bandwidths, and
- there is at least a 5 dB drop in level within two bandwidths on the opposite side.

The presence of a pure tone, as defined above, is required in order to declare that there is an LFN problem. Where a clear tone is present below and including 250 Hz and the difference between the overall C-weighted sound level and the overall A-weighted sound level exceeds 20 dB, remedial action may be required to reduce the impact of the LFN (see appendix 3).

4.1.2 Multiple Days of Monitoring

In order to ensure that representative conditions have been monitored, multiple days of noise monitoring (with each day being 24 hours) may be a solution if there is uncertainty regarding what representative conditions might be prior to monitoring or what they have been during monitoring.

The following are some of the reasons to conduct multiday monitoring:

- conditions not representative of the complaint,
- requirement for minimal hours of valid data not achieved,
- changing weather conditions,
- changing atmospheric conditions (such as inversions),
- changing plant operating conditions,
- variable seasonal effects,
- significant contamination from distant noise sources,
- insufficient local meteorological data, and
- prior agreement on an extended monitoring period in order to satisfy mutual concerns between residents and licensees.

The following are reasons for accepting a single day of monitoring or for concluding a multiday survey:

- favourable and stable weather conditions (see section 4.2),
- "achievement" of representative conditions, as described in the Noise Complaint Investigation form,
- agreement from complainant that survey conditions were appropriate, and
- licensee acknowledgement that compliance is not achieved.

Generally, a single-day noise survey should be sufficient if representative conditions have been achieved and the licensee has been diligent. Section 4.2 describes suitable conditions for a single-day noise survey. Alternatively, a multiday survey may be necessary if representative conditions in section 4.2 are not met. Finally, the AER may require more surveys if either the complainant or the licensee demonstrates such a need.

40) For multiday monitoring, the results from each day must be evaluated against this directive. If multiple days are deemed to be representative, the worst-case condition (e.g., highest nighttime Leq) is compared to the PSL.

4.2 Noise Monitoring Conditions

The completed Noise Complaint Investigation form is used to determine conditions representative of the complaint. If this completed form is not available, table 4, which outlines the recommended noise monitoring conditions, is used. Measurements should be conducted when sound propagates towards the impacted dwelling and it is likely that representative conditions exist.

Invalid data may result if wind speeds are greater than those shown in table 4. Wind gradients can greatly affect the sound levels measured. The table is less applicable in situations where hills exist between the facility and the measurement location.

41) Appropriate judgement must be used in determining the applicability of the table; short-term wind gusts less than five minutes in duration and up to 20 km/hr may be acceptable.

Note that the limits for wind speed (measured at a height between 1.2 and 10 m based on the judgement of the acoustical consultant) and precipitation apply at the measurement position, not at a remote sensing position many kilometres away. While data from a location nearby (nearest meteorological station) may serve as an indicator, that does not guarantee the same conditions at the measurement position. Licensees may want to consider measuring wind speed and direction using a meteorological station at the monitoring location to ensure accurate data.

Table 4. Favourable summertime weather conditions

Parameter	Preferred condition
Ground cover	No snow, water, or ice (frozen) ground cover
Precipitation	No steady precipitation
Wind speed	Wind speed limits (noise data may be invalid if limits are exceeded): Less than 500 m from noise source Upwind: 10 km/hr limit Crosswind: 15 km/hr limit Downwind: 15 km/hr limit 500–1000 m from noise source Upwind: 5 km/hr limit Crosswind: 10 km/hr limit Downwind: 10 km/hr limit Greater than 1000 m from noise source Upwind: less than 5 km/hr limit Crosswind: 10 km/hr limit Downwind: 10 km/hr limit 24-hour noise sampling period: there should be at least 3 hours of wind blowing directly to the complainant in the nighttime sampling period (22:00 to 7:00) and 3 hours in the daytime sampling period (7:00 to 22:00)

42) If a wintertime complaint is received, the appropriate representative conditions must be determined, and a survey conducted under those or similar conditions.

4.3 Noise Survey Analysis

4.3.1 Methodology for Assessing Multiple Noise Sources

Each case of multiple noise sources presents its own complexities.

43) An appropriate methodology for assessment of multiple noise sources or isolation techniques is based on the professional judgement of an acoustical consultant or investigator and must be documented in the noise investigation report.

Examples of techniques that may be used follow:

- If the sound levels at the receiver are due to the cumulative contributions from several sources or energy-related facilities, the relative contributions of each source or facility at the nearest or most impacted dwelling must be determined in order to address noise control options. This is most commonly done by assessing the PWL of each contributor or a measured sound pressure level at a standard distance where each individual source is dominant.
- If the facilities are separated, the relative sound emission of each can be determined by taking measurements in the direction of the receiver at points where each source or facility, in turn, is completely dominant. Usually, these measurements are conducted at a common distance in the far field.
- If the facilities are close enough that the sound fields overlap or if there are elevated sources that may not be adequately taken into account at the fence line (due to vertical directionality of the sources), professional judgement must be used.

44) At points where two or more sources contribute, the relative contributions must be determined using good engineering practices and must be explained in the report.

For example, extensive near-field diagnostic surveys can be conducted at the various source facilities, with computer-aided modelling, to properly assess the source contributions. This is most useful if the noise has particular characteristics that are major factors in the noise complaint. A complete diagnostic survey is also useful for ranking the sources to most effectively focus noise control efforts.

4.3.2 Isolation Analysis

Isolation analysis techniques consist of various sound measurements and methods used to separate out sound sources and obtain the sound level from the source of interest alone. During a comprehensive noise survey, all sound levels are captured for the survey period. However, in a compliance survey, noise contributions from the licensee’s facility are of particular interest.

45) In cases where the noise survey results exceed the PSL but noise from the facility and its related activities may not be responsible for the exceedance, further assessment using an appropriate isolation technique must be carried out to separate the facility noise contribution from the measured CSL.

Invalid or abnormal data should be extracted from the measured CSL. Invalid data can include periods with unacceptable meteorological conditions or nonrepresentative ground cover. Temperature inversions or lapse conditions are excluded unless they are considered a frequent occurrence (that is, they occur more than 10 per cent of the time for a particular season) and can be captured at the receptor site. Such conditions affect the receptor's perception of noise, but unless the event occurs with regularity due to local topography or other factors, the condition is dismissed. Abnormal data are those from noise events such as aircrafts and animals.

46) The extraction of data from the measured CSL must be justified and supported by an appropriate reference, such as a digital or analog audio recording, operational log, or event log.

47) The accumulated isolated facility contribution data must encompass the previously stipulated minimum time period.

Criteria for removing data:

- exceedance of maximum wind speed
- measurement periods when precipitation is present
- measurement periods where the monitor is upwind of the source
- periods of noise dominated by biological activity, typically at dawn or dusk, such as birdcalls, frogs (such periods are commonly referred to as the "Dawn Chorus")
- abnormal noise events, including aircraft flyovers and off-plant site vehicular traffic (on-site noise is controlled by the facility, but off-site noise is under the authority of the responsible municipal jurisdiction and therefore not subject to AER control)
- other sources of noise not under AER jurisdiction, such as non-AER-regulated industries (such noise sources are typically under the jurisdiction of the local municipal authority)

4.4 Components of a Comprehensive Sound Level Survey

48) In most noise-related complaint situations, the licensee contribution to the CSL must be measured and compared to the PSL. The CSL (after isolation analysis) for the facility must not exceed the PSL.

49) The CSL is determined by conducting a continuous sound monitoring survey, which must encompass a representative portion of the times of day or night on days when the noise causing the complaints typically occurs.

Modelling of the industrial noise source component can be used as a diagnostic tool to assist in the timely resolution of noise concerns but not to demonstrate compliance.

50) Reports summarizing results of a noise survey used to show compliance with this directive must include (at a minimum) the following information:

a) completed Noise Complaint Investigation form (Parts 1 and 2) identifying the representative conditions for monitoring—if not available, an explanation for why it was not used,

b) distance and direction of dwelling from the facility (include a map),

c) record of calibration results,

d) environmental conditions during monitoring period (wind speed and direction) and the source of the data,

e) operating conditions for facility or facilities included in the survey,

f) graphs showing measured sound levels and any isolation analysis,

g) summary table including the PSL for dwelling, measured sound level, isolation analysis results, and valid hours of the survey, and

h) in cases where LFN was identified as a potential problem, the analysis and results.

4.5 Measurement Instrumentation and Techniques

4.5.1 Measurement Instrumentation

51) Instrumentation used to conduct sound monitoring surveys must be able to measure the A-weighted (dBA) and/or C-weighted (dBC) continuous energy equivalent sound level (Leq) of steady, intermittent, and fluctuating sounds. It must be able to accumulate the data and calculate the Leqs over the time periods required and must meet the minimum technical specifications in the International Electrotechnical Commission (IEC) 61672 standard for Class 1 sound level meters.

52) The sound measurement instrumentation necessary to conduct the ⅓ octave band sound pressure level measurements to characterize the presence of tonal components must meet the minimum technical specification in the IEC 61260 standard or American National Standards Institute (ANSI) S1.11 standard for Class 1 filter sets used in conjunction with conventional

sound level meters that meet the minimum technical specifications in the IEC 61672 standard or ANSI S1.4 standard for Class 1 sound level meters.

4.5.1.1 Calibrator Certification Requirements

53) Calibrators must be recertified in accordance with the Acoustical Society of America (ASA)/ANSI S1.40 standard, which requires that a calibrator be recalibrated at least once a year.

4.5.1.2 Sound Level Meter Calibration Requirements

It is important that the sound level meters used for noise surveys be properly calibrated and functioning.

54) The sound level meters used for noise measurements made under this directive must

  a) meet the latest version of the ANSI S1.4 and S1.4A standards;

  b) be calibrated within a two-year period immediately preceding the measurements by the instrument manufacturer, an authorized instrument calibration facility, or another agency acceptable to the AER, and the records of calibration must be maintained, although formal calibration certificates are not necessary;

  c) be calibrated immediately prior to the measurement with a sound calibrator meeting the latest version of the ASA/ANSI S1.40 standards; and

  d) have their calibration confirmed immediately after the measurement using the same calibrator and a record of calibration results must be included in the report.

55) Meters that fail a pre-use or post-use calibration test (i.e., the meter does not read within ±1 dB) must be reviewed for accuracy, applicability, and cause of deviation. Any data found to be corrupt must not be used.

4.5.2 Measurement Techniques

The sound measurement techniques employed are to be carefully chosen and controlled to obtain valid and consistent results. Factors to take into account include the effects of meteorological factors, activities in the vicinity of the sound meter, suitability of the monitoring location, and topographical features.

General guidelines for sound measurement techniques are found in the following publications:

- *Environmental Noise Guideline – Stationary and Transportation Sources – Approval and Planning* (*NPC-300*), issued by the Government of Ontario
- *ANSI/ASA S1.13: Measurement of Sound Pressure Levels in Air*

- *ISO 1996: Acoustics — Description, Measurement and Assessment of Environmental Noise*, issued by the International Organization for Standardization

56) Users must also ensure that the instrumentation is working within manufacturer's specifications and limitations.

5 Compliance

5.1 Noise Complaints

A facility is in compliance if a CSL survey conducted at representative conditions has results equal to or lower than the established PSL, taking into consideration any LFN. Alternatively, if the AER agrees that a CSL survey is not practical, a detailed noise management plan (NMP) approved by the AER may be used.

5.2 Noise Management Plans

57) An NMP must include

    a) identification of noise sources,
    b) assessment of current noise mitigation programs,
    c) performance effectiveness of noise control devices,
    d) methods of noise measurement,
    e) best practices programs, and
    f) continuous improvement programs.

58) In all cases, an NMP must be discussed with and incorporate input from all affected persons, such as local neighbours, regulated and nonregulated industries, and local government. The AER is willing to assist in the process if requested by the lead industrial operator.

The AER may conduct random comprehensive sound surveys on facilities and audits on facility applications. The AER requires sound levels to be in compliance and NIAs to be complete and technically relevant.

If unsure about the requirements for an NIA, a licensee should contact an appropriate acoustical engineering consultant or the AER.

Appendix 4 show example problems that outline the process to determine compliance.

Appendix 1 Glossary

Some of the terms used in this directive are defined for this particular context; these definitions are not necessarily the same as the generally accepted broader definitions of the terms.

abnormal noise events	Noises that are sufficiently infrequent as to be uncharacteristic of an area or that occur so close to the microphone as to dominate the measurements in an unrealistic manner. Consideration must be given to deleting occurrences of abnormal noise from the measurements to obtain a reasonably accurate representation of the sound environment. Examples of abnormal noises include a dog barking close to the microphone, a vehicle passing nearby, people talking in the vicinity of the microphone in a quiet environment, or a passing road grader.
ambient noise	All noises that exist in an area and are not related to a facility covered by *Directive 038.* Ambient noise includes sound from other industrial noise not subject to this directive, transportation sources, animals, and nature.
ambient sound level (ASL)	The sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The ASL does not include any energy-related industrial component and must be measured without it. The ASL can be measured when the sound level in an area is not believed to be represented by the basic sound levels in table 1. The ASL must be measured under representative conditions. As with comprehensive sound levels, representative conditions do not constitute absolute worst-case conditions (i.e., the most quiet day in this case) but conditions that portray typical conditions for the area. Also see *Representative conditions*.
A-weighted sound level	The sound level as measured on a sound level meter using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear at levels typical of rural backgrounds in mid frequencies. See figure 2.
background noise	The total noise from all sources that currently exist in an area. Background noise includes sounds from the energy industry, as well as other industrial noise not subject to this directive, transportation sources, animals, and nature.

bands (octave, ⅓ octave) A series of electronic filters separate sound into discrete frequency bands, making it possible to know how sound energy is distributed as a function of frequency. Each octave band has a centre frequency that is double the centre frequency of the octave band preceding it.

The ⅓ octave band analysis provides a finer breakdown of sound distribution as a function of frequency.

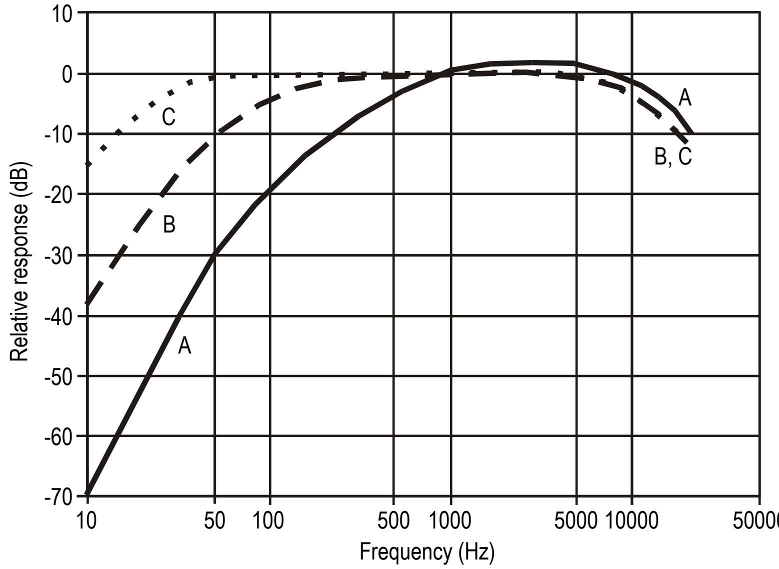


Figure 2. Weighting network curves

basic sound level (BSL) The A-weighted Leq sound level commonly observed to occur in the designated land-use categories with industrial presence. The BSL is assumed to be 5 dBA above the ASL and is set out in table 1.

calibration The procedure used for the adjustment of a sound level meter using a reference source of a known sound pressure level and frequency. Field calibration must take place before and after the sound level measurements.

Category A classification of a dwelling unit in relation to transportation routes used to arrive at a BSL.

Category 1 Dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers. Also see *Category*.

Category 2 Dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers. Also see *Category*.

Category 3 Dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers. *Also see Category*.

Class A adjustment Consists of the sum of adjustments that account for the seasonal nature of the noise source (cannot be used for design state) and the actual ambient sound level in an area. It cannot exceed +10 dBA.

Class B adjustment An adjustment based on the duration of a noisy activity that recognizes that additional noise can be tolerated if it is known that the duration will be limited. An adjustment of B1, B2, B3, or B4 may be selected as applicable.

comprehensive sound level (CSL) The sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The CSL does include industrial components and must be measured with them, but it should exclude abnormal noise events. The CSL is used to determine whether a facility is compliant with this directive. Also see *Representative conditions*.

cumulative noise level The sound level that is the total contribution of all industrial noise sources (existing and proposed) from AER-regulated facilities at the receptor.

C-weighted sound level The C-weighting approximates the sensitivity of human hearing at industrial noise levels (above about 85 dBA). The C-weighted sound level (i.e., measured with the C-weighting) is more sensitive to sounds at low frequencies than the A-weighted sound level and is sometimes used to assess the low frequency content of complex sound environments. See figure 2.

day Twenty-four-hour calendar day.

daytime Defined as the hours from 7:00 a.m. to 10:00 p.m.

daytime basic sound level Daytime ambient sound levels are generally about 10 dBA higher than nighttime values.

dB (decibel) A unit of measure of sound pressure that compresses a large range of numbers into a more meaningful scale. Hearing tests indicate that the lowest audible pressure is about 2×10^{-5} Pa (0 dB), while the sensation of pain is about 2×10^{2} Pa (140 dB). Generally, an increase of 10 dB is perceived as twice as loud.

$$\text{Sound pressure level (dB)} = 10 \log \left(\frac{p^2}{p_o^2} \right) = 20 \log \left(\frac{p}{p_o} \right)$$

p = root-mean-square sound pressure (Pa)

p_o = reference root-mean-square sound pressure, generally 2×10^{-5} Pa

The decibel is a linear weighting and can also be used when referring to differences in weightings.

dBA The decibel (dB) sound pressure level filtered through the A filtering network to approximate human hearing response at low intensities. Also see *dB* and *A-weighted sound level*.

deferred facility	Facilities constructed and in operation prior to October 1988 where equipment installed before October 1988 is the major noise source on site.
density per quarter section	Refers to a quarter section with the affected dwelling at the centre (a 451 m radius). For quarter sections with various land uses or with mixed densities, the density chosen is the average for the area under consideration.
dwelling unit	Any permanently or seasonally occupied residence with the exception of an employee or worker residence, dormitory, or construction camp located within an industrial plant boundary. Trailer parks and campgrounds may qualify as a dwelling unit if it can be demonstrated that they are in regular and consistent use during the applicable season.
dwelling unit (most impacted)	The nearest dwelling unit may not necessarily be the one most adversely affected because of factors such as topography or man-made features. For example, the nearest dwelling unit to a facility may be behind an intervening ridge, while a more distant dwelling unit may be in direct line of sight with the facility. Care must be taken in determining the most impacted dwelling unit. Also see *Dwelling unit*.
emergency	An emergency means a present or imminent event outside the scope of normal operations that requires prompt coordination of resources to protect people's health, safety, or welfare or limit damage to property and the environment.
energy equivalent sound level (Leq)	The Leq is the average weighted sound level over a specified period of time. It is a single-number representation of the cumulative acoustical energy measured over a time interval. The time interval used should be specified in brackets following the Leq—e.g., Leq (9) is a 9-hour Leq. If a sound level is constant over the measurement period, the Leq will equal the constant sound level. If the sound level shows a variety of constant levels for different intervals, then f_i is the fraction of time the constant level L_i is present. $$\text{Leq} = 10\log\left(\sum_{i=1}^{n} f_i \times 10^{L_i/10}\right)$$ See appendix 2 for more details on the Leq concept.

far field The far field is that area far enough away from the noise source that the noise emissions can be treated as if they come from a single point or line source and the individual components of the noise source are not apparent as separate sources. This is typically at a distance of at least three to five times the major dimensions of the noise source.

The far field may consist of two parts, the free part and the reverberant part. In the free part, the sound pressure level obeys the inverse-square law (6 dBA loss per doubling of distance for a point source). The reverberant part exists for enclosed or semi-enclosed situations where there are many reflected sound waves from all directions. An example of a reverberant field is industrial equipment enclosed in a room.

fast response Fast response has a time constant of 125 milliseconds on a sound level meter. Also see *Slow response*.

filter A device separating the components of an incoming signal by its frequencies.

frequent aircraft flyovers Used in the assessment of categories as part of a site-specific analysis for dwellings that lie within a contour area with a noise exposure forecast (NEF) 25 or greater, as designated by Transport Canada. In the absence of any NEF contours for a local airport, Transport Canada is to be contacted for current air traffic statistics. In this case, to qualify for the BSL adjustment, a dwelling must be within 5 km of an airport that has a minimum of nine aircraft takeoffs or landings over the nighttime period. Also see *Noise exposure forecast*.

heavily travelled road Generally, includes highways and any other road where the average traffic count is at least 10 vehicles/hour over the nighttime period. It is acknowledged that highways are sometimes lightly travelled during the nighttime period, which is usually the period of greatest concern. The AER will use the 10 vehicles/hour criterion to determine whether highways qualify as heavily travelled during the nighttime period.

heavy industrial area Usually, an area zoned by the appropriate municipality containing or meant to contain a concentration of large industrial complexes, thereby helping licensees avoid a multiplicity of industrial effects on surrounding residents. A buffer zone is generally established between the industrial facilities and where people live so that there are no dwellings situated among industrial facilities.

heavy truck Any truck having a gross vehicle weight of 12 000 kg or more and having three or more axles.

industrial development permit facility	Industrial development permit facility is any development where the total quantity of energy in the energy resource used in any year as a raw material or fuel, or both, in the industrial or manufacturing operation exceeds one petajoule, and the quantity of energy in the energy resource used in that year as a raw material in the industrial or manufacturing operation exceeds 100 terajoules, such as oil refinery or chemical production plants.
isolation analysis techniques	Various sound measurements and analytical skills used to separate out various sound sources and obtain the sound level from the source of interest alone.
Leq	See *Energy equivalent sound level*.
linear weighting (or Z weighting)	The sound level measured with the linear weighting measures the acoustic pressure without any adjustment for the sensitivity of human hearing. It is a direct measure in decibels of the variation in air pressure and is often referred to as the “sound pressure level.” This level is sometimes called the “linear weighted level” or “the unweighted level,” as it includes no frequency weighting beyond the tolerances and limits of the sound level meter being used for the measurements.
low frequency noise (LFN)	Where a clear tone is present below and including 250 Hz and the difference between the overall C-weighted sound level and the overall A-weighted sound level exceeds 20 dB.
near field	The region close to the source where the inverse-square law (6 dBA loss per doubling of distance for a point source) does not apply. Usually this region is located within a few wavelengths of the source and is also controlled by the dimensions of the source.
nighttime	Defined as the hours from 10:00 p.m. to 7:00 a.m.
noise	Generally associated with the unwanted portion of sound.
noise exposure forecast (NEF)	The NEF contours are site specific to each airport and take into account such factors as traffic levels, proximity to runways, flight paths, and aircraft type and size.
noise impact assessment (NIA)	An NIA predicts the expected sound level emanating from a facility at the nearest or most impacted dwelling or 1.5 km from the facility fence line if there are no closer dwellings. It also identifies what the permissible sound level is and how it was calculated.
no net increase	The logarithmic addition of sound pressure levels when predicting noise where the sum does not exceed the permissible sound level by 0.4 dBA.
pass-by	The movement of a vehicle past the point of measurement and observed as an increase in sound level to a peak, followed by a decrease as the vehicle moves away from the microphone.
permanently occupied dwelling	A fixed residence occupied on a full-time basis.

permissible sound level (PSL) The maximum sound level that a facility must not exceed at a point 15 m from the nearest or most impacted dwelling unit. The PSL is the sum of the nighttime/daytime BSL, Class A adjustment, and Class B adjustment.

pristine area A pure, natural area that might have a dwelling but no industrial presence, including energy, agricultural, forestry, manufacturing, recreational, or other industries that already impact the noise environment.

rail lines Includes any rail line where there is a minimum of one 25-car train passage during every nighttime period.

representative conditions Those conditions typical for an area and/or the nature of a complaint. For ASLs, these are conditions that portray the typical activities for the area, not the quietest time. For CSLs, these do not constitute absolute worst-case conditions or the exact conditions the complainant has highlighted if those conditions are not easily duplicated. Sound levels must be taken only when representative conditions exist; this may necessitate a survey of extensive duration (two or more consecutive nights).

seasonally occupied dwelling A fixed residence that, while not being occupied on a full-time basis, is occupied on a regular basis. A regular basis does not imply a scheduled occupancy but implies use of six weeks per year or more. The residence must not be mobile and should have some sort of foundation or features of permanence (e.g., electrical power, domestic water supply, septic system) associated with it. Summer cottages or mobile homes are examples of seasonally occupied dwellings, while a holiday trailer simply pulled onto a site is not.

slow response A standardized detector response on a sound level meter that dampens the movement of displays so that rapidly fluctuating sound levels may be read. Slow response has a time constant of 1 second, which helps average out the display fluctuations.

sound level meter An instrument designed and calibrated to respond to sound and to give objective, reproducible measurements of sound pressure level. It normally has several features that would enable its frequency response and averaging times to be changed to make it suitable to simulate the response of the human ear.

sound monitoring survey The measurement and recording of sound levels and pertinent related information over a given time period.

Directive 038 sets out two types of monitoring surveys. The first helps determine the PSL and consists of a 24-hour continuous sound monitoring survey conducted 15 m from the nearest or most impacted dwelling unit without any energy-related industrial presence. This type of sound survey can be used to determine an ASL. Also see *Ambient sound level*.

The second type of sound monitoring survey is required to determine a facility's compliance with *Directive 038*. The CSL is determined by conducting a continuous sound monitoring survey over a minimum 6-hour period. Also see *Comprehensive sound level*.

sound power level (PWL, SWL, L_W) The decibel equivalent of the rate of energy (or power) emitted in the form of noise. The sound power level is given by

$$\text{Sound power level} = 10\log_{10}\left(\frac{\text{Sound as power}}{W_o}\right)$$

$$\text{By international agreement, } W_o = 10^{-12} \text{ watts}$$

However in some older data (roughly pre-1975), the value of W_o was set as 10^{-13} W (no longer used). The sound power level is an inherent property of a noise source.

sound pressure level (SPL, L_P) The decibel equivalent of the pressure of sound waves at a specific location, which is measured with a microphone. Because human reaction and material behaviours vary with frequency, the sound pressure level may be measured using frequency bands or with an overall weighting scale such as the A-weighting system. The sound pressure level depends on the noise sources, as well as on the location and environment of the measurement path.

spectrum A wide range or sequence of frequencies.

summertime conditions Ground cover and temperatures that do not meet the definition for wintertime conditions. These can occur at any time of the year.

temporary facility Any facility that will be in operation less than 60 days.

tonal components (low frequency) The test for the presence of tonal components consists of two parts. The first must demonstrate that the sound pressure level of any one of the slow-response, A-weighted, ⅓ octave bands between 20 and 250 Hz is 10 dBA or more than the sound pressure level of at least one of the adjacent bands within two ⅓ octave bandwidths. In addition, there must be a minimum of a 5 dBA drop from the band containing the tone within 2 bandwidths on the opposite side.

The second part is that the tonal component must be a pronounced peak clearly obvious within the spectrum.

An example of tonal component determination is shown in appendix 3.

windscreen	A specialized piece of porous sponge that fits over the microphone in order to reduce the noise generated by the wind blowing around the microphone. Useful in moderately low wind speeds. Generally, outdoor measurements are not recommended when wind speeds exceed 15 km/hr, as the wind-induced noise on the microphone becomes of the same magnitude as the levels of noise being measured.
wintertime conditions	There is snow, ice, or frozen ground cover and temperatures are below 0°C.

Appendix 2 Sound Level Descriptors

dB and dBA

The human ear is capable of hearing a large range of levels of sound pressure from 2×10^{-5} pascals (Pa) (just audible, 0 dB) to 2×10^{2} Pa (sensation of pain, 140 dB)—a difference of seven orders of magnitude. The decibel is a logarithmic scale and is used to compress the range of sound pressure levels into a more meaningful scale. The symbol used to represent the linear decibel scale is dB(Lin), or simply dB.

The subjective or perceived loudness of a sound is determined by several factors, including the fact that the human ear is not equally sensitive to all frequency ranges. The ear emphasizes middle frequency sounds. The A-weighted decibel scale approximates the way the human ear hears different frequencies and is represented by dB(A) or dBA. (See “A-weighted sound level” in appendix 1 and figure 2, “Weighting network curves.”)

For example, low frequency sounds (hum) are harder for the human ear to hear than higher frequency sounds (whine). This means a low frequency sound would have a higher sound pressure level on the linear scale (dB) than a high frequency sound and yet would be perceived to be equally loud to the ear. These two sounds would have the same dBA rating on the A-weighting scale because they are perceived to be equally loud.

Leq Concept

This directive uses Leq measurements, which represent energy equivalent sound levels. The Leq is the average weighted sound level over a specified period of time—a single-number representation of the cumulative acoustical energy measured over the interval. The time interval used should be specified in brackets following the Leq (e.g., Leq [9] is a 9-hour Leq). If a sound level is constant over the measurement period, the Leq will equal the constant sound level. Figure 3 illustrates this concept.

$$\text{Leq} = 10\log\left(\sum_{i=1}^{n} f_i \times 10^{L_i/10}\right)$$

where f_i = Fraction of total time the constant L_i is present

L_i = Sound level in dBA

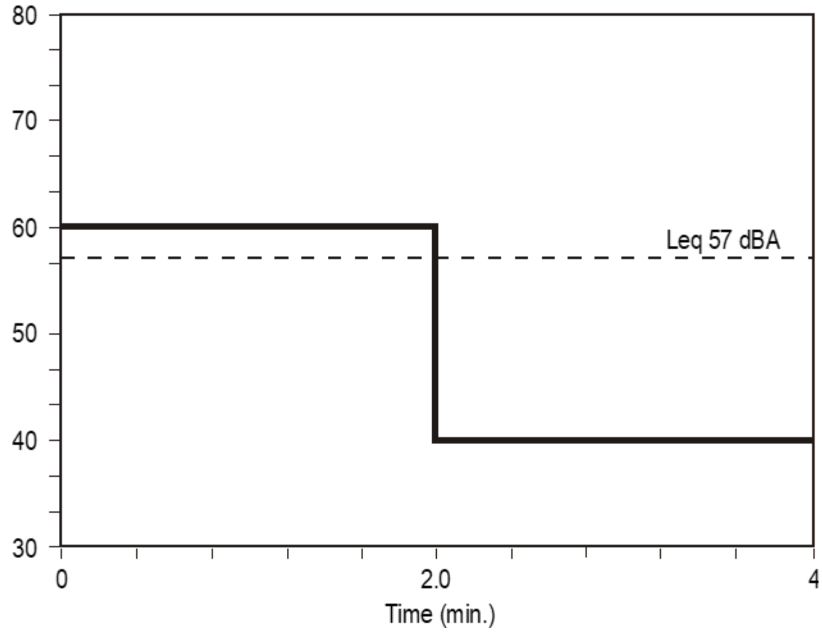


Figure 3. Illustration of Leq concept

In figure 3, the equivalent energy during the 4-minute period is not 50 dBA, as one might expect, but 57 dBA. This is due to the way in which sound energies are added, which is logarithmical rather than arithmetic. A quick look at the mathematics shows this:

For figure 3, which has 4 minutes of 1-second Leq values:

$$\begin{aligned}\text{Leq} &= 10\log\left(\sum_{i=1}^{n} f_i \times 10^{L_i/10}\right)\\ &= 10\log\left(\sum_{1}^{240} f_i \times 10^{L_i/10}\right)\\ &= 10\log\left(\frac{120}{240} \times 10^{60/10} + \frac{120}{240} \times 10^{40/10}\right)\\ &= 10\log(505\,000)\\ &= 57\text{ dBA Leq }(4\text{ min})\end{aligned}$$

In these calculations, we are adding numbers that are proportional to the corresponding sound energies. For example, the energy associated with the 60 dBA level is 100 times greater than the energy associated with the 40 dBA level (10^6 versus 10^4).

Another example of a Leq calculation is useful in demonstrating how a loud noise event, such as a train passing by, can alter the Leq value. Assume the sound level is measured for 1 hour. For 59 minutes, the sound level is 40 dBA (fairly quiet), and for 1 minute it is 90 dBA while a train passes:

$$\begin{aligned}\text{Leq} &= 10\log\left(f_1 \times 10^{L_1/10} + f_2 \times 10^{L_2/10}\right)\\ &= 10\log\left(\frac{59}{60} \times 10^{40/10} + \frac{1}{60} \times 10^{90/10}\right)\\ &= 10\log(0.98 \times 10^4 + 0.02 \times 10^9)\\ &= 73 \text{ dBA Leq (1 hour)}\end{aligned}$$

This example demonstrates how loud noise events, such as trains passing, can dominate the Leq values.

Sound Power and Sound Pressure Levels

A sound source radiates power, which results in a sound pressure. Sound power is a physical property of the source alone and is an important absolute parameter used for rating and comparing sound sources. Sound power levels for specific equipment may be obtained from the manufacturer or by modelling the source using near-field sound pressure level measurements.

Sound pressure levels can be calculated using sound power levels. For sound levels in a free field, the formula is

$$L_{pressure} = L_{power} + 10\log_{10} Q - 20\log_{10} r - 10.8 - A_{NC} - A_{air} - A_{ground} - \ldots$$

where r = distance, in metres

Q = directivity factor of source, composed of inherent directivity of the source, Q_s, and the geometry of location, Q_g

A = attenuation from noise control, air absorption, ground effects, etc.

For simplicity, with an exposed source in a free field (e.g., the distance, r, is greater than 5 times the size of the source and there are no significant reflections of sound) where additional attenuation factors are to be neglected, this calculation can be done using A-weighted power and pressure levels. This gives a conservative estimate of the sound pressure level at a distance, but not necessarily the “worst-case” level that may occur under weather conditions favouring noise propagation in a given direction, which can be considered as a negative attenuation.

If any noise control measures are to be added to the source (such as a silencer or a building that will enclose the source) or if environmental conditions (such as the barrier effect of the topography) are to be included, the calculations must be done using octave or ⅓ octave frequency bands and the sound pressure levels added together and A-weighted afterwards. Noise controls and environmental effects are strongly frequency dependent, and a calculation using A-weighted data is not adequate.

The directivity factor, Q, can be thought of as the portion of a sphere into which the source radiates its sound energy. Some sources radiate uniformly in all directions, while others, notably fans, are very directional. For example, a fan in a vertical plane radiates most of the sound energy in a narrow beam to the front: ($Q_s \approx 5$ to 8).

The directionality of the source is also affected by the geometry of its immediate surroundings, largely due to the presence of reflecting surfaces. The directivity of the location may or may not be significant due to the inherent directivity of the source. How the directivity factors Q_s and Q_g combine depends on the layout of the equipment and its surroundings. Table 5 gives examples of values of Q for a variety of location geometries.

Table 5. Q values

Q	Radiation pattern	Examples
1	Spherical	Elevated sources, flares, aircraft
2	Hemispherical	Source near or on ground surface
4	¼-spherical	Source on ground beside taller building
8	⅛-spherical	In a corner of three surfaces

Addition of Sound Power or Sound Pressure Levels

A similar formula to the one used in the section “Leq Concept” in this appendix can be used to add sound levels together both for the A-weighted levels and in frequency bands. This formula is useful for adding together sound power or sound pressure levels from different components of a plant, for example, to arrive at a composite sound level for the plant.

Sound pressure levels can be added together in this way only if they are measured or calculated for the same location.

Sound power levels can be added together and the composite source can be thought of as being at the acoustic centre of the individual sources (similar to the concept of the centre of mass of an object).

Estimate of Sound Pressure Levels for Different Distances

Point Sources

This estimate assumes hemispherical spreading of the sound waves and equates to a 6 dB loss per doubling of distance from the sound source. The calculation does not account for any attenuation (or loss) due to atmospheric or ground absorption.

This method of calculation can only be used in the following circumstances:

a) Simplified or other informal calculations are only acceptable for a smaller stationary single source facility without any existing industrial infrastructure and with flat ground between the facility and a single dwelling at a close distance or in remote areas where there are no dwellings within 1.5 km of the facility.

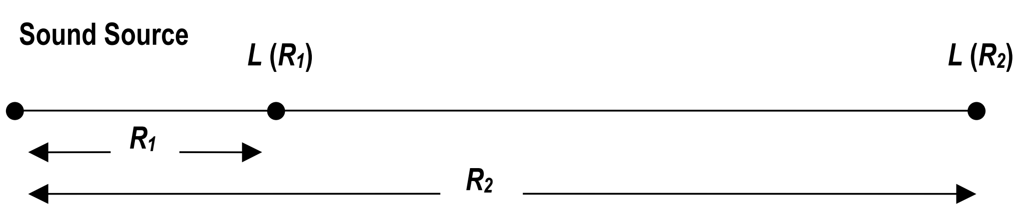
b) An acceptable distance for applying the inverse-square law depends on the sound source dimensions and the wavelength of the sound. The formula is usually safe to use as long as R_1 and R_2 are about five times the size of the source. Alternatively, a minimum distance of 50 m can be used as a rule of thumb.

c) The inverse-square law (6 dB loss per doubling of distance) for sound dissipation over distance does not apply for "near-field" measurements. The near field is the area where the dimensions of the source are significant; it applies to sound pressure levels measured at distances less than about five times the size of the source object. The data supplied by manufacturers are often provided as sound pressure levels measured very close to the equipment (i.e., in the near field) and are intended for use under occupational hearing requirements rather than for environmental assessment. Note that such measurements are often conducted using conditions that may not reflect field or operational conditions. Therefore, this type of measurement cannot be used in the equation below. However, given additional information about the dimensions of the equipment and the conditions of the measurement, the sound power level of the equipment can be determined, and the equation from the section "Sound Power and Sound Pressure Levels" in this appendix can be used instead.

In other circumstances, it may be advisable to contact an acoustical consultant.

The basic equation is:

$$L(R_2) = L(R_1) - 20\log_{10}\left(\frac{R_2}{R_1}\right)$$



where R_1 = distance R_1 in metres

R_2 = distance R_2 in metres

L = sound level in dBA

Note that if R_2 is less than R_1, the second term in the equation is negative and $L(R_2)$ is higher than $L(R_1)$. Also, under certain source-receiver configurations, the loss per doubling of distance can be less than 6 dB.

Example Calculation of Determining the Sound Level at a Different Distance

The sound level specification you are given is 75 dBA for the compressor package at 50 m away. You have a dwelling 800 m away from your facility. What is the compressor sound level measured at the dwelling?

You know that L(50 m) = 75 dBA.

$$L(R_2) = L(R_1) - 20\log_{10}\left(\frac{R_2}{R_1}\right)$$

$$L(800\text{ m}) = L(50\text{ m}) - 20\ \log\left(\frac{800}{50}\right)$$

$$L(800\text{ m}) = 75\text{ dBA } - 20\ \log\left(\frac{800}{50}\right)$$

$$L(800\text{ m}) = 75\text{ dBA } - 24\text{ dBA}$$

$$L(800\text{ m}) = 51\text{ dBA}$$

So the sound level contribution due to the compressor is 51 dBA at 800 m. A simpler, more intuitive way to do the calculation is illustrated below.

Alternative Method of Determining the Sound Level at a Different Distance—Simple Table Approach

A simplified way to estimate the sound level is based upon using the rule of 6 dB lost per doubling of distance. With this method, you simply make a table and subtract 6 dB each time you double the distance from the noise source.

If we use the 75 dBA at 50 m specification:

Distance (m)	Sound level (dBA)
50	75
100	69
200	63
400	57
800	51
1600	45

From this simple method, you get 51 dBA at 800 m. This matches the calculation above. The simple table method only allows you to get sound values at discrete distance points. If sound values between the distance points are required, use the calculation method.

Line Sources

Where a long, narrow source radiates noise, the radiation pattern is that of a cylinder, not a sphere. Examples include pipes, conveyor belts, and transportation corridors, such as roads. Calculations using the spherical spreading of sound from point-like sources would involve a final step of integration over the length of the sound. It is more convenient to treat the sound as a line radiating into a cylinder. The pressure level at distance *R* is considered below. If the length, *L*, of the line source is limited, once the distance, *R*, exceeds three to five times the length, the source can be considered as a point source, and the equations in the sections "Sound Power and Sound Pressure Levels" and "Point Sources" in this appendix can be used.

For a line source, the sound spread equates to a 3 dB loss per doubling of distance. Similar conditions apply for the line source equation as for the point source equation. The formula for noise levels at different distances from a line source is as follows:

$$L(R_2) = L(R_1) - 10\log_{10}\left(\frac{R_2}{R_1}\right)$$

where R_1 = distance R_1 in metres

R_2 = distance R_2 in metres

L = sound level in dB (for octave bands) or dBA

Note that if $R_2 < R_1$, the second term in the equation is negative, and $L(R_2)$ is higher than $L(R_1)$.

Appendix 3 Determination of Low Frequency Tonal Component

The methodologies shown below are intended as guidelines only and should not restrict the methods of a qualified investigator or acoustical consultant. The AER will review the proposed methodology and approve the techniques or require other methods, as deemed appropriate. As PSLs are typically higher in the daytime than during the night, the methods described focus on the nighttime periods. However, the LFN concerns may be due to activities during the daytime only. The methodologies remain similar.

As part of the pre-evaluation of a potential problem with LFN, the investigator should determine the quality of the noise that has raised concerns from the affected resident(s) and assess whether the noise problem is intermittent or continuous.

Continuous LFN

If there is an LFN concern and it is continuous, the levels should be measured over the entire nighttime period in terms of the ⅓ octave Leq and statistical levels (L_{10}, L_{50}, L_{90}, or some combination). The difference in the Leq (equivalent-continuous) levels for adjacent spectral bands should be graphed in order to demonstrate whether there is a pure tone, as defined above. If the difference in the levels varies over the nighttime, this will be evident from such a graph.

When measurements are taken over the entire period of the nighttime, the measurement subinterval should be a maximum of one minute. In this case, the statistical levels are valuable to show any shorter term fluctuations in levels.

Intermittent LFN

If the suspected LFN is intermittent, then short-term measurements should be taken at times when the low frequency sound is present, and the assessment of the presence of a tone should be restricted to times when the sound is present. A high-quality audio recording of the sound over the period of concern may need to be taken for later analysis and identification of the duration and intensity of the LFN. If the timing of the intermittent periods is not regular, a continuous measurement may be required to obtain sufficient evidence of the presence or absence of a pure tone.

In this case, the spectral analysis can be done in terms of a short-term Leq or a “slow” weighted sound level. Many instruments do allow simultaneous measurements of the ⅓ octave Leq levels. If meters cannot track all the ⅓ octave frequency bands at the same time, the tonal components can be assessed by running a taped signal through an analyzer a number of times to get the levels of all the frequency bands of interest. The analyzer would be for “slow response” and the recordings run with different ⅓ octave band settings until all bands between 20 and 250 Hz have been analyzed.

Importance of Wind Conditions

In all cases where LFN may be a consideration, measurements of the local wind conditions must be taken throughout the assessment period at a height of 1.2 m to 10 m above ground in the vicinity of the sound monitoring location(s) based on the professional judgement of the acoustical consultant. Wind generates high levels of low frequency (and infrasonic) sound energy, which can mask or confuse the assessment of industrial LFN.

Example

The table below shows how the presence of low frequency tonal components is determined. For example, a tonal component is evident at 250 Hz (≥10 dB within 2 bandwidths on one side and ≥5 dB drop within 2 bandwidths on the other side, in addition to being pronounced within the spectrum).

Table 6. One-third octave band frequency spectrum analysis for tonal components

		Part 1		Part 2
Band (Hz)	**Sound level (dB)**	**Maximum Δ dB within 2 bandwidths**	**≥5 dB on other side?**	**Pronounced within the spectrum**
20	10	−4	n/a	n/a
25	12	−2	n/a	n/a
31.5	14	4	n/a	n/a
40	13	−4	n/a	n/a
50	14	−3	n/a	n/a
63	17	4	n/a	n/a
80	14	−6	n/a	n/a
100	15	−8	n/a	n/a
125	20	−8	n/a	n/a
160	23	−11	n/a	n/a
200	28	8	n/a	n/a
250	34	11	**yes**	**yes**
315	31	3	n/a	n/a
400	28	−6	n/a	n/a

The figure below shows some examples of tonal components. There is clearly a tonal component (pronounced peak) within the spectrum at 250 Hz and 2000 Hz (≥10 dB within 2 bandwidths on one side and ≥5 dB drop within 2 bandwidths on the other side); however, the second is at a frequency greater than 250 Hz and would not be considered low frequency noise.

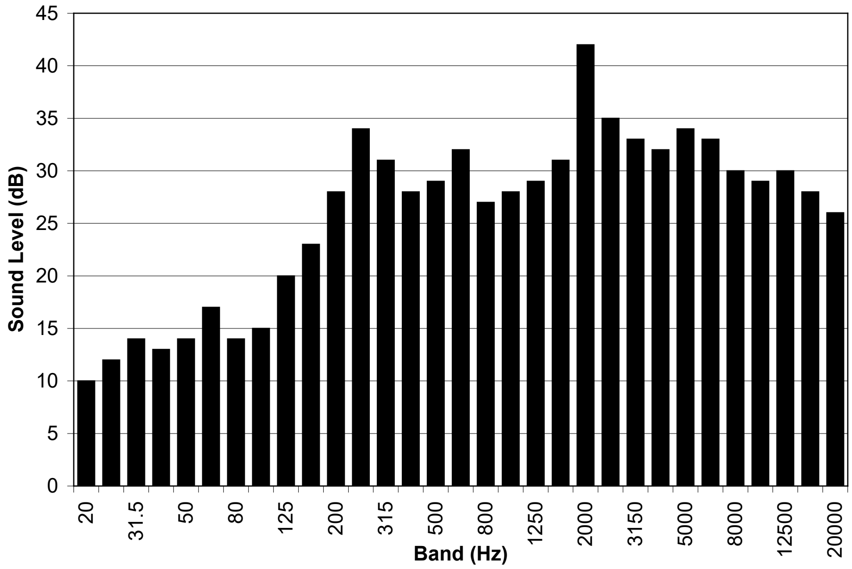


Figure 4. One-third octave band centre frequency (Hz)

Appendix 4 Example Problems

The example problems below show a step-by-step process to determine compliance or noncompliance for any new or existing facility.

Problem 1

A new compressor station is proposed for the area shown below. What sound levels should the facility be designed for?

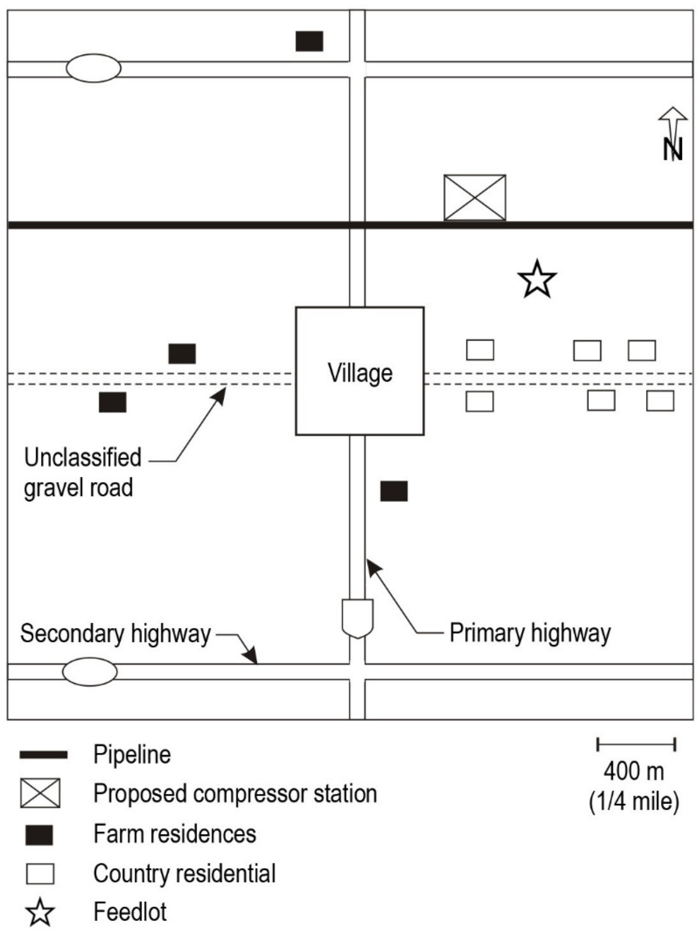


Figure 5. Area sketch for problem 1

Problem 1 – Solution

Step 1 Determine the BSL for nighttime.

All three possible dwelling unit densities are represented in this area.

- The four farm residences and the six country residential dwellings fall into the 1–8 dwellings range.

- A portion of the village is in the 9–160 dwellings range.
- Most of the village is in the greater than 160 dwellings range.

The transportation proximity categories are as follows:

- The two farm residences next to the primary highway fall into category 2.
- The two farm residences on the gravel road are category 1.
- The dwellings in the village fall into category 2 or 3, depending on the distance from the primary highway.
- The six country residential dwellings fall into category 1 (farther along the gravel road).

It appears that the country residential dwellings directly to the south of the proposed compressor station are probably the most sensitive, being category 1 units. This gives a nighttime BSL of 40 dBA Leq, from table 1.

Note: Some preliminary calculation of expected sound levels and attenuation may be useful in determining the worst-impacted dwelling. For instance, the nearest dwelling, located at the northeast corner of the village, may be a category 2, while a more distant country residential dwelling may be category 1. Some elementary calculations may be necessary to determine the worst case.

Step 2 Are daytime sound levels required?
No, as the lower sound level is the one that must be designed for and the nighttime level is usually lower.

Step 3 Seasonal adjustment?

No, because this adjustment cannot be added when determining the PSL for design purposes.

Step 4 Is the BSL appropriate for this area?

Assume no, because of presence of nonregulated noise source in area (feedlot that operates 24 hours). The licensee of this proposed compressor station has taken some spot measurements with a handheld sound meter. The levels recorded ranged from 35dBA at night to 55 dBA during the day. Consult with the AER and obtain approval for using the A2 adjustment.

Step 5 An ambient sound monitoring study 15 m from the nearest country residential dwelling prior to construction of the facility must be conducted to claim A2 adjustment.

The results of the survey are

Daytime ASL: 53 dBA Leq

Nighttime ASL: 37 dBA Leq

After receiving approval for using the A2 adjustment. Claim A2 adjustment from figure 1. First, subtract the ASL measured in this step from the BSL in step 1.

Daytime BSL − daytime ASL = 50 − 53 = −3

Nighttime BSL − nighttime ASL = 40 − 37 = +3

For each in turn, locate this difference on the horizontal axis of figure 1, read upward until the adjustment line is intersected, and read to the left to find the applicable adjustment A2.

Daytime adjustment: A2 = +8 dBA Leq

Nighttime adjustment: A2 = + 2 dBA Leq

Step 6 Sum of adjustments: A1 + A2 (let's call it A)

Daytime: 0 + 8 = 8 dBA Leq

Nighttime: 0 + 2 = 2 dBA Leq

Step 7 Is A greater than 10 dBA Leq?

In either case, no.

Class A adjustment = 8 dBA daytime

Class A adjustment = 2 dBA nighttime

Step 8 Is noise temporary in nature?

No. The compressor station will operate all year.

Class B adjustment: B = 0 dBA

Step 9 Determine the PSL using the equation in 2.1.

Daytime					**Nighttime**				
PSL	=	BSL (Day)	+A	+B	PSL	=	BSL (Night)	+A	+B
PSL	=	40+10	+8	+0	PSL	=	+40	+2	+0
		PSL =	58 dBA Leq				PSL =	42 dBA Leq	

Step 10 Daytime PSL = 58 dBA Leq

Nighttime PSL = 42 dBA Leq

As measured 15 m from the nearest acreage dwelling unit.

Problem 2—Noise Impact Assessment

A new compressor station is proposed for the area shown in figure 6. What is the predicted sound level at the nearest or most impacted dwelling?

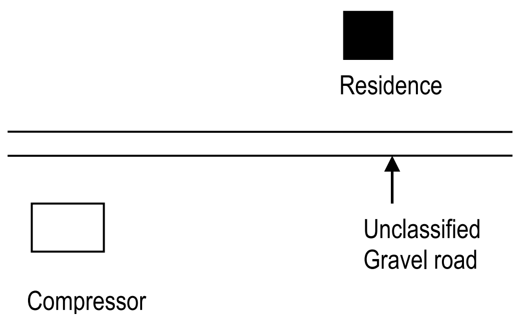


Figure 6. Area sketch for problem 2

Problem 2 – Solution

The NIA developed for this problem would include the following:

- The major sources of noise in this facility include cooler fans and exhaust noise. The manufacturer of this equipment has stated that the maximum sound level from all the equipment is 60 dBA measured at 50 m in front of the cooler fan.
- The sound levels at the nearest dwelling have been predicted using a theoretical 6 dBA loss per doubling of distance. No additional losses for air absorption, excess ground attenuation, or facing the cooler fan away from the dwelling have been calculated. The only input is the 60 dBA criterion at 50 m.
- The distance to the most impacted dwelling is 600 m to the northeast. This also happens to be the closest dwelling. If we extrapolate the 60 dBA value out to 600 m, using the theoretical 6 dBA loss per doubling of distance:

$$L(R_2) = L(R_1) - 20\log\left(\frac{R_2}{R_1}\right)$$

$$L(600\text{ m}) = 60 - 20\log\left(\frac{600}{50}\right)$$

$$L(600\text{ m}) = 60 - 21.6$$

$$L(600\text{ m}) = 38.4\text{ dBA}$$

So the predicted facility sound level at the dwelling is 38.4 dBA.

Adding the predicted facility sound level of 38.4 to the ambient sound level of 35 dBA would give a combined predicted sound level of 40.0 dBA, calculated as follows:

$$\text{Leq} = 10\log\left(\sum_{i=1}^{n} f_i \times 10^{L_i/10}\right)$$

$$= 10\log\left(10^{38.4/10} + 10^{35/10}\right)$$

$$= 10\log(10080)$$

$$= 40.0 \text{ dBA}$$

- The most impacted dwelling is along an unclassified gravel road, so it is in category 1 proximity to transportation. The dwelling density falls into the 1–8 dwellings range. Based upon these two factors, the BSL is 40 dBA at night, from table 1. No other adjustments are being used, so the PSL is 40 dBA Leq nighttime.

The assessment indicates that the predicted sound level is 40.0 dBA. This meets the PSL of 40 dBA during the nighttime, calculated above. The assessment also indicates that the facility will meet the requirements in *Directive 038.* If the facility receives any complaints, they will be investigated promptly, and if the facility is not meeting the directive’s requirements, remedial action will be undertaken to rectify the situation and bring the facility into compliance with the noise directive.

No further attenuation measures need to be considered at this time.