

Rule 012

Noise Control

The Alberta Utilities Commission (Commission) has approved amendments to this rule on January 26, 2011.

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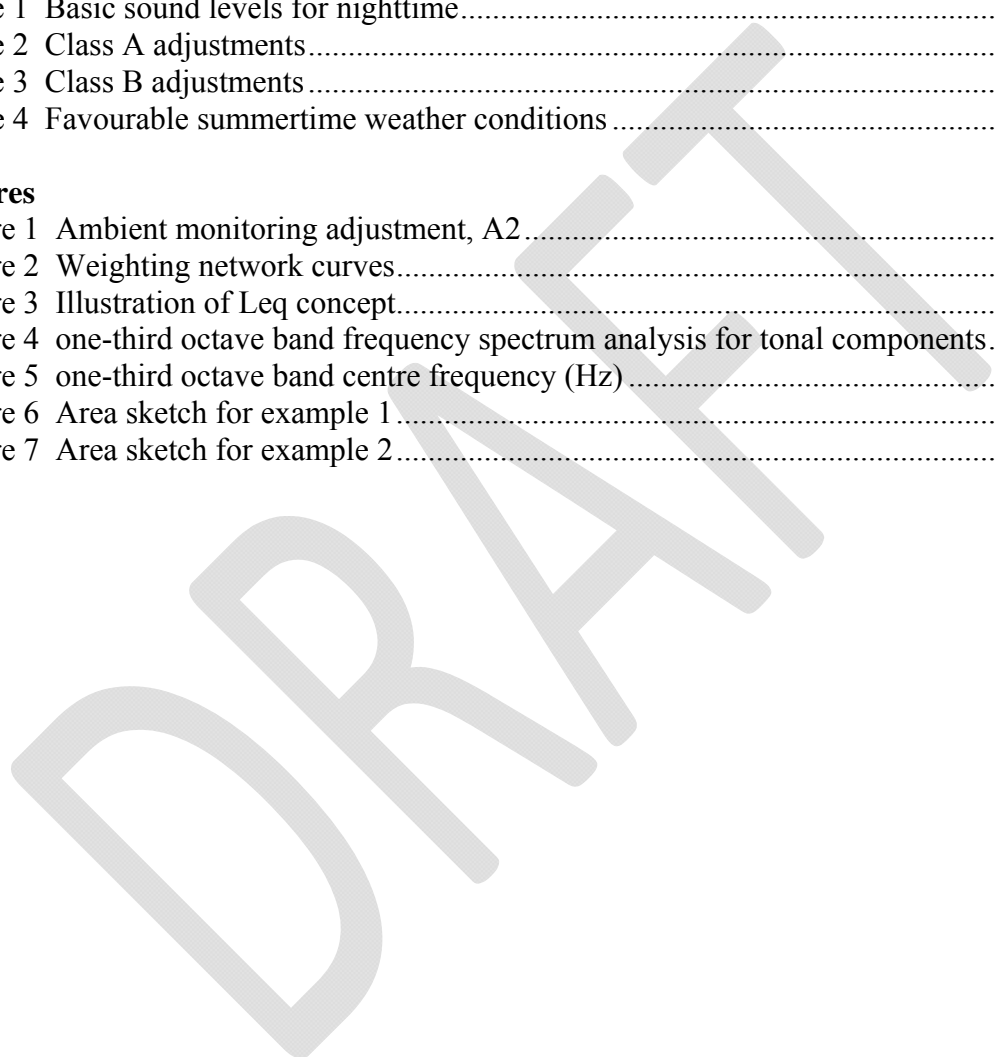
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1 General provisions

1.1 Definitions

In this rule,

- (a) “Commission” means the Alberta Utilities Commission;
- (b) “facility” means a gas utility pipeline, hydro development, power plant, substation, and transmission line;
- (c) “gas utility pipeline” has the same meaning as in the [Gas Utilities Act \(GU Act\)](#);
- (d) “hydro development”, “power plant”, “substation” or “transmission line” has the same meaning as in the [Hydro and Electric Energy Act \(HEE Act\)](#); and,
- (e) “licensee” means the holder of a licence or approval for a facility in accordance with the records of the Alberta Utilities Commission.

1.2 Rule application

Subject to section 2.3, this rule applies to a permanent or temporary facility and the operation of a facility including noise related to construction of a facility.

1.2.1 Purpose of rule

The purposes of this rule are to ensure that noise from a facility, cumulatively with other noise sources, does not exceed the permissible sound level (PSL) calculated in accordance with this rule and to set out a process to evaluate noise complaints relating to a facility.

1.3 Permissible sound level (PSL)

A facility must meet the PSL determined in accordance with Section 2 where dwelling(s) may be affected by noise.

Where there are no potentially-affected dwellings near the facility, a PSL of 40 decibels absolute energy level equivalent (dBA L_{eq}) nighttime must be met at 1.5 km from the boundary of the facility property.

For the purpose of determining compliance with this rule, noise is measured at a distance of 15 metres from the nearest or most impacted dwelling, rather than at the property line of the land on which the dwelling is located.

1.4 Existing facility

When a licensee is notified that a person is proposing to build a dwelling within 1.5 km of the facility property, the licensee must communicate existing noise levels from the facility to that person using the noise impact assessment for the facility, existing noise survey data or modeling data extrapolated to the proposed building site.

A licensee must keep documentation of communication between the licensee and a person proposing to build near the facility and a copy of the noise impact assessment or other data provided to that person.

Where a dwelling is built within 1.5 km of an existing facility, the PSL for the new dwelling will be the greater of the existing noise level at the time of construction or the PSL as calculated in Section 2.

2 Permissible sound level (PSL)

2.1 Determination of permissible sound level

(1) The PSL is determined for the nearest or most impacted dwelling(s) within 1.5 km measured from the facility property and is the value assigned to that dwelling. The PSL is based on summertime conditions.

(2) The PSL is calculated as follows:

$$\begin{array}{rcccccc} \text{Permissible} & = & \text{Basic sound} & + & \text{Daytime} & + & \text{Class A} & + & \text{Class B} \\ \text{sound level} & & \text{level (BSL)} & & \text{adjustment} & & \text{adjustment} & & \text{adjustment} \\ \text{(PSL)} & & \text{(Table 1)} & & \text{(Item (4) below,} & & \text{(Table 2)} & & \text{(Table 3)} \\ & & & & \text{if applicable)} & & & & \end{array}$$

(3) Nighttime basic sound levels (BSLs) are determined from Table 1. The BSL is determined to be 40 dBA L_{eq} (5 dBA L_{eq} 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*

| Proximity to transportation | Dwelling density per quarter section of land | | |
|-----------------------------|---|---|--|
| | 1 - 8 dwellings; 22:00 - 07:00 (nighttime) (dBA L_{eq}) | 9 - 160 dwellings; 22:00 - 07:00 (nighttime) (dBA L_{eq}) | >160 dwellings; 22:00 - 07:00 (nighttime) (dBA L_{eq}) |
| Category 1 | 40 | 43 | 46 |
| Category 2 | 45 | 48 | 51 |
| Category 3 | 50 | 53 | 56 |

***Notes:**

- The assumed nighttime ambient sound level is five dBA less than the applicable BSL.
- The assumed daytime ambient sound level is five dBA less than the applicable BSL plus the daytime adjustment.
- Category 1—dwellings more than 500 metres from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
- Category 2—dwellings more than 30 metres but less than 500 metres from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
- Category 3—dwellings less than 30 metres from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers.

- Documentation regarding whether a road is heavily travelled must be compiled and submitted with the noise impact assessment to support the Table 1 category used.
- Density per quarter section—refers to a quarter section with the affected dwelling at the centre (a 451 metre radius). For quarter sections with various land uses or with mixed densities, the density chosen is then averaged for the area under consideration.
- See Appendix 1 for more definitions.

- (4) Daytime adjustment means the daytime adjustment of 10 dBA L_{eq} above the nighttime PSL and daytime is the period between 7 a.m. and 10 p.m.
- (5) Class A adjustments are based on the nature of the activity or the actual measured Ambient Sound Level (ASL) in an area and referred to in Table 2.

In either case, an applicant must apply in writing for an approval from the Commission to apply a Class A adjustment, before filing an application for the facility to which the Class A adjustment is applied in the noise impact assessment. The application for the Class A adjustment must include data in support of the request. Only if the Commission grants the Class A adjustment application may the adjustment be applied.

Table 2 Class A adjustments*

| Class | Reason for adjustment | Value (dBA L_{eq}) |
|-------|--|-----------------------|
| A1 | Seasonal adjustment (wintertime conditions) | + 5 |
| A2 | Ambient monitoring adjustment See Figure 1 below | -10 to +10 |

*Class A adjustment = Sum of A1 and A2 (as applicable), but not to exceed a maximum of 10 dBA L_{eq} .

- a. A1—Seasonal adjustment for wintertime noise complaints must not be added when determining the PSL for design purposes. The PSL may be modified to reflect site-specific conditions for a wintertime noise 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.
- b. A2—An adjustment to the ASL which is the average sound environment in a given area without the contribution of noise from any energy-related industry. An adjustment for a 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. Two cases where it may be necessary to determine the ASL are:
- areas considered to be pristine (defined in Appendix 1); and
 - areas with non-energy industrial activity that would impact the ASLs.

Licensees may conduct a background survey to determine the total noise levels that currently exist in an area for information purposes, such as energy-related industry, non-energy industry, and transportation.

- c. An ambient sound monitoring survey consists of a 24-hour continuous sound monitoring survey, with measured ASL presented for the daytime and nighttime periods under representative conditions. The survey is conducted

15 metres from the dwelling being considered for the Class A adjustment. The 15 metre requirement may be altered if it is physically impossible or acoustically illogical. If the affected dwelling is not in an acceptable location, another suitable measurement site may be chosen. An ambient sound survey must be conducted without any energy-related facility components.

- d. A licensee must use Figure 1 to determine the appropriate adjustment value, A2, which will be added to any other applicable Class A adjustment factor.

To use Figure 1:

1. Determine the difference between the BSL (Table 1) for the appropriate dwelling density and transportation proximity and the measured ASL to the nearest whole number.
2. Look up this difference on the horizontal axis of Figure 1.
3. Move up on the figure until the plotted line is intersected.
4. Move left on the figure to the vertical axis and read off the applicable A2 adjustment factor; it may be positive or negative.
5. Add this adjustment factor to any other applicable Class A adjustment factor(s) to arrive at the Class A adjustment. If the sign of A2 is negative, you will be adding a negative number to arrive at the Class A adjustment.

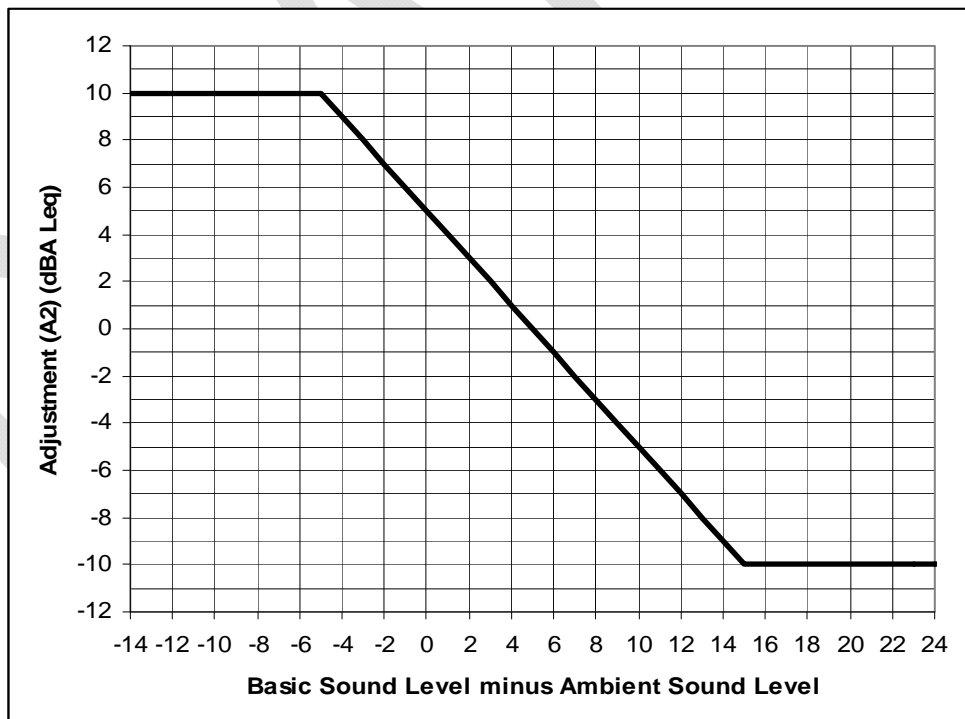


Figure 1 Ambient monitoring adjustment, A2

- (6) Class B adjustments are values intended to permit adjustments to the BSLs based upon people's responses to temporary noise generating activities which means activities lasting 60 or less days and occurring no more than once every

12 months. 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 | Value (dBA L _{eq}) |
|-------|----------------------|------------------------------|
| B1 | 1 day | + 15 |
| B2 | 7 days | + 10 |
| B3 | ≤ 60 days | + 5 |
| B4 | > 60 days | 0 |

- (7) A licensee must keep technical information to support the licensee's use of any of the adjustments to the BSL.

2.2 Exceptional situations

- (1) For exceptional situations or areas, the Commission assesses the PSL on a site-specific basis.
- (2) The PSL determined under this rule does not apply in an emergency which is an unplanned event requiring immediate action to prevent loss of life or property. Events occurring more than four times a year at a facility are not considered unplanned.

2.3 PSL determination for pre-1988 facilities

- (1) A facility constructed and in operation before October 17, 1988 is considered to be a deferred facility, meaning that it does not have to demonstrate compliance in the absence of a noise complaint.
- (2) If a noise complaint is filed with the Commission against a deferred facility where a PSL has not been previously established, the licensee must calculate the PSL in accordance with sections 2.1 and 2.2 of this rule.
- (3) For facility applications where there is no existing noise complaint, the measured sound level established from a previous or new comprehensive sound level (CSL) survey will become the PSL for any expansion or modification to that facility subsequent to 1988 if the sound level is currently above the PSL determined in accordance with Section 2 until October 17, 2018 (see paragraph (5)).
- (4) A licensee must reduce existing noise from sources at the facility to make room for the introduction of new noise sources so that there is no increase in total noise emitted from the facility.
- (5) Effective October 17, 2018, the Commission will eliminate the deferred status for facilities built and in operation prior to 1988. Any application received after this date for modification or expansion of a deferred facility must demonstrate compliance with the PSL as defined in Section 2.1.

2.4 PSL determination for a new facility near a deferred facility

Where a new facility is proposed to be constructed near a deferred facility, PSLs that are determined based on the deferred facility status may be used until October 17, 2018, only while the deferred facility is operational.

3 Noise impact assessments

3.1 Preparation of a noise impact assessment

- (1) An applicant for a facility must prepare a noise impact assessment that includes the potential noise impacts of the proposed facility under normal facility operating conditions, which is to be filed with the Commission as one document attached to the application.
- (2) A noise impact assessment is conducted to predict the sound level from the proposed facility at the nearest or most impacted dwelling.
- (3) If a noise complaint is filed by a resident near the facility after the facility is in operation, the licensee must meet the PSL as determined in accordance with Section 2.
- (4) An applicant planning a facility in an area where there is an existing or proposed energy-related facility present must ensure that its facility will not cause the L_{eq} sound levels to exceed the PSL. If the existing noise levels are higher than the PSL (only for deferred facilities where no complaints have been received), the applicant must ensure that its facility will not cause an increase in L_{eq} sound levels.

3.2 Noise impact assessment requirements

- (1) A noise impact assessment is required for a new facility or modifications to an existing facility where the proposed facility or modification will be emitting sound once constructed.
- (2) Where a noise impact assessment is not submitted, an applicant must justify why noise levels are not affected by the proposed facility or proposed modifications to a facility in the application.

An applicant must complete a noise impact assessment before filing an application for a new facility or modification to an existing facility, and submit the noise impact assessment with the application.

- (3) If the noise impact assessment indicates noncompliance with the PSL, the applicant must:
 - provide for additional attenuation measures, or
 - submit reasons why the measures proposed to reduce the impacts are not practical.

3.3 Comparing predicted noise level to the PSL

The predicted sound pressure level emanating from a facility is added to the assumed ASL. The assumed ASL is 5 dBA less than the BSL (Table 1). The predicted noise levels of the facility plus the ASL and any energy-related facilities must be compared to the PSL. A dwelling may have only one PSL.

For intermittently operated permanent equipment or facilities (e.g. wind turbines, peaking units), predictions used for comparison to the PSL are evaluated for the duration of equipment operation and not on the short term duration averaged over the entire daytime or nighttime period.

3.4 Cumulative noise environment

- (1) The cumulative noise level of the assumed ASL, existing and proposed energy-related facilities, and the predicted noise from the applicants proposed facilities when combined must not exceed the PSL.
- (2) Licensees must use accepted acoustical practices, equipment, and techniques when measuring or modeling sound levels.
- (3) If measurements are used in the noise impact assessment, the method for measuring sound must meet the requirements set out in Section 4 of this rule.
- (4) The simplified method of reducing six dBA per doubling of distance is only acceptable for a smaller stationary single-source facility without any existing energy-related facility cumulative effect and with flat ground between the facility and a single dwelling or at 1.5 km distance as detailed in Section 2.5 of Appendix 2. In cases where the simplified approach is not acceptable, a licensee must use an acoustical practitioner to predict the cumulative noise level. When requested, a licensee must make available to the Commission all noise modeling documentation.
- (5) In cases where there is no existing dwelling within 1.5 km of a facility property and the facility is adjacent to another energy-related facility so that the 1.5 km radius overlaps, compliance with the PSL in the overlapping portion is not evaluated. (See Example 3 in Appendix 6.)

3.5 Noise models

- (1) The noise model must incorporate the following parameters:
 - geometric spreading;
 - barrier effects;
 - atmospheric absorption;
 - ground attenuation; and
 - specific wind speed/direction.

Consideration must be given to:

- source identification;
- source size, location, and elevation;
- isolation analysis;
- sound power level (PWL) and/or sound pressure level (SPL) spectral data;
- intermittency; and
- mild downwind and/or temperature inversion conditions.

(2) The following input parameters must be used in modeling summertime conditions for an acceptable noise impact assessment:

- wind speed: five to 7.5 km per hour (km/hr) (see Section 3.7 for wind turbines);
- wind direction: from the facility to the dwelling(s);
- temperature: 0 C to 25 C;
- relative humidity: 70 per cent to 90 per cent; and
- topography and ground cover: consistent with site conditions.

Models must meet accepted protocols and international standards (e.g., CONCAWE or ISO 9613).

(3) The predicted sound pressure levels for a facility that operates intermittently (for example, a peaking unit), is calculated based on noise generated for the duration of the operation and is not averaged over all of the nighttime or daytime period.

3.6 Low frequency noise

If available, C-weighted sound pressure level (dBC) minus the A-weighted sound pressure level (dBA) is to be considered in the noise modeling of new facilities or facility modifications or expansions to identify and minimize the potential for low frequency noise impacts (see Appendix 5).

3.7 Wind turbines

(1) For any new wind turbines, an applicant must prepare a noise impact assessment that meets the criteria set out in sections 2 and 3.

(2) When selecting the locations of wind turbines, licensees must limit noise levels at any dwelling to the PSL determined in accordance with Section 2. Wind turbine noise must be modeled using wind speeds of six to nine metres per second (m/s) or 21 to 32 km per hour (km/h) to predict a worst-case condition. At these wind speeds, the wind turbine noise may be greater than or equivalent to the wind noise.

- (3) The modeling must also include cumulative effects of adjacent wind turbines and adjacent energy-related facilities. The predicted noise levels must be compared to the PSL (predicted noise level from wind turbines, existing energy-related facilities and assumed ASL).

3.8 Requirements for an acceptable noise impact assessment

An acceptable noise impact assessment must include the following information:

- (1) Permissible sound level:

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

- (2) Sound source identification:

Identify all major sources of noise such as transformers, heat recovery steam generators, exhaust and pump noise, ventilation openings or other equipment from the energy-related facilities and their associated sound power/pressure levels in octave bands.

Indicate whether the sound data is from vendors, field measurements, theoretical estimates or another source. 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.

- (3) Operating conditions:

- (4) 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).

The following must be clearly stated within the noise impact assessment:

- type of model used (models or hand calculations may be used to obtain the predicted sound level);
- standards followed;
- 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, for example source size considerations).

- (5) Outline of study area:

Include a figure, map, area plan or drawing showing the proposed facility, study area and the nearest or most impacted dwelling(s). The figure, map, area plan, or drawing must be clearly labelled, include a scale, and indicate either geographic coordinates or legal land descriptions.

(6) If sound levels are determined using estimates as outlined in Section 2.5 of Appendix 2, the noise impact assessment must clearly show that the conditions in that section are met.

(7) Predicted sound level/compliance determination:

Identify what the predicted cumulative sound level will be at the nearest or most impacted dwelling(s). If there are differences between day and night operations, both levels must be calculated. Indicate whether the facility is in compliance with requirements.

(8) Non-compliance determination/attenuation measures:

If the predicted sound level indicates noncompliance with this rule, identify the attenuation measures that the applicant/licensee is committing to and the timeline to implement measures to attain compliance.

If the predicted sound level indicates noncompliance with this rule and further attenuation measures are not practical, the noise impact assessment must include the reasons why the measures proposed to reduce the impacts are not practical.

(9) Acoustical practitioner's information:

Provide the name(s) and describe the role(s), directly-related training and experience of the person(s) who prepared the noise impact assessment as well as the professional affiliations of the person(s).

3.9 Records

A licensee must keep all supporting information relating to a noise impact assessment in the event that the Commission requests the information, and for reference if a noise complaint is filed. See Appendix 3 for a Noise Impact Assessment Summary Form.

4 Noise complaint investigations

(1) Licensees must make every reasonable attempt to resolve any noise-related complaint in a timely manner.

(2) When investigating a noise complaint, licensees must first attempt to resolve the issue through direct contact (via documented telephone calls or meetings) with the complainant to understand the concerns and establish a dialogue.

(3) When a noise complaint is filed with the Commission, the Commission may require the licensee to conduct a comprehensive sound level (CSL) survey to determine compliance with this rule.

- (4) If a facility is found to be noncompliant, the licensee must provide both a detailed noise control mitigation plan and a timeline for when compliance will be met.
- (5) When the facility meets the requirements in this rule, the Commission ends its investigation.
- (6) If conditions at the facility change, a new complaint may be filed.
- (7) A noise complaint cannot be filed against a deferred facility as a result of gathering noise emission data as part of an application for modification of the facility.

4.1 Process for comprehensive sound level (CSL) survey

- (1) If a CSL survey is to be performed, the licensee and the complainant must complete Part 1, and if possible Part 2 of the Noise Complaint Investigation Form in Appendix 4 to identify the conditions that exist when noise is affecting the resident. If the complainant does not participate in the completion of the Noise Complaint Investigation Form, the licensee must submit documentation of its attempts to directly engage the complainant in the completion of the form.

In the noise impact assessment, if a facility was modeled to operate with doors and windows closed, this is a condition of operation to ensure that the PSL is met.

- (2) In Part 1 of the Noise Complaint Investigation Form, the licensee must enter information from the resident(s) about the quality and characterization of the noise to help determine the source of the noise. Part 1 also examines the weather and ground cover conditions that exist when the noise is most annoying to the resident(s). 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 4.5).

- (3) Part 2 of the Noise Complaint Investigation Form, the event log, is designed for use by the resident(s) concerned about the noise generated by the Commission-regulated facilities. Residents complaining about noise are encouraged to record details about environmental and facility operating conditions under which noise adversely affects them.
- (4) CSL surveys must encompass a representative portion of the time of day or night when the noise causing the complaint typically occurs. The surveys should be

conducted at the first opportunity when the representative conditions can be reasonably met.

- (5) A licensee 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.
- (6) If the complainant does not complete Part 1 of the Noise Complaint Investigation Form, the licensee must use its best judgment to determine representative conditions, and provide an explanation in the report for the absence of the form. In addition, the licensee must explain how the representative conditions were determined.
- (7) A monitoring period may vary from nine to 24 hours, depending on the type, time, and duration of the noise. There must be at least three continuous hours of valid data (after isolation analysis) for the nighttime period and three continuous hours for the daytime period (if required) for the survey to be considered valid. The measurements are to be conducted 15 metres from the complainant's dwelling in the direction of the noise source. The 15-metre requirement may be altered if it is physically impossible or illogical from an acoustical consideration.
- (8) If the PSL was established for deferred facilities using modeling results, the outcome of the CSL must be adjusted if necessary, taking into account the input conditions used to generate the modeled results. For example, if the PSL was determined by inputting calm summer conditions in the model, the CSL must be measured under similar seasonal and meteorological conditions.
- (9) When the measured CSL exceeds the PSL but noise from the facility and its related activities is not considered to be responsible for the excess, a further assessment using an appropriate isolation analysis technique to separate the facility noise contribution from the measured CSL may be carried out (see Section 4.7 (2)). This method will separate noises not related to the facility. The isolated facility contribution can then be compared to the PSL for compliance.

4.2 Low frequency noise in CSL survey

A-weighting measurements typically discount the lower frequencies. Therefore, low frequency noise (LFN) may be an issue in some situations where the dBA value is satisfactory but the concern is a dominant low frequency that increases annoyance levels at dwellings. Due to the complexity of determining LFN, this is a specialized investigation. The procedure outlined below and in Appendix 5 is only completed in specific response to an LFN complaint identified through the complaint investigation process and as a second-stage investigation.

- (1) If the potential for LFN exists, measurements must be conducted in both C- and A-weighted scales concurrently. Measurements may be made using two 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 condition may exist when:

- the isolated (i.e., non-facility 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).
- (2) If LFN is confirmed to exist, a five dBA L_{eq} penalty will be added to the CSL results. If this value exceeds the PSL, the licensee must 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 and complaint investigation must be conducted to confirm that the LFN condition has successfully been addressed.

Wind generates high levels of low frequency sound that can mask the assessment for LFN. Measurements of LFN should only be taken when atmospheric conditions are favourable for accurate measurement (see Table 4 and Appendix 5).

4.3 Determination of tonal component

The following conditions indicate the presence of a low frequency pure tone in the noise measured at a dwelling.

For the one-third octave frequency bands of 250 Hz or below:

- (a) the linear sound level of one band must be at least 10 dB or more above one of the adjacent bands within two one-third octave bandwidths; and
- (b) there must be at least a five dB drop in level within two bandwidths on the opposite side of the high frequency band.

The presence of a pure tone, as defined above, is required in order to declare that there is LFN. Where a clear tone is present below 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 5).

4.4 Wind turbines and CSL survey

Generally, the “cut-in” wind speed (minimum wind speed required to start the turbines) for a wind turbine exceeds the maximum wind speeds for typical CSL surveys. Therefore, to accurately measure the true noise output from the turbine, it is necessary to minimize the impact of wind noise on the results. For wind turbines, noise measurements, including CSLs, are recommended to be conducted for wind speeds between four and six m/s (about 14 and 22 km/hr) measured between a height of 1.2 and 10 metres above grade. Wind speed must be measured in the vicinity of the microphone in a manner that does not affect the noise measurement.

4.5 Multiple nights or single night of monitoring

- (1) In order to ensure that representative conditions have been monitored, multiple nights of noise monitoring may be required to address uncertainty regarding what representative conditions might be prior to monitoring or what they have been during monitoring.
- (2) The following are some of the reasons to conduct multiple-night 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.
- (3) The following are reasons for accepting single-night monitoring or for concluding a multiple-night survey:
 - favourable and stable weather conditions (see Section 4.6);
 - 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.
- (4) Each night result for multiple-night monitoring must be evaluated against the requirements of this rule. If multiple nights are deemed to be representative, the worst-case condition (highest nighttime L_{eq}) is compared to the PSL.

4.6 Noise monitoring conditions

- (1) The completed Noise Complaint Investigation Form is used to determine conditions representative of the complaint. If this completed form is not available, Table 4 outlines the recommended noise monitoring conditions. Measurements should be conducted when sound propagates towards the nearest or most impacted dwelling.
- (2) Invalid data (except in the case of wind turbine noise monitoring) may result if wind speeds are greater than those shown in Table 4. Wind gradients can greatly affect the sound levels measured. Table 4 is less applicable in situations where hills exist between the facility and the measurement location. Judgment 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.

- (3) Note that the limits for wind speed (measured at a height between 1.2 metres and 10 metres based on the judgment of the acoustical practitioner) and precipitation apply in the vicinity of the measurement, not at a remote sensing position many kilometres away. While data from a nearby meteorological station may serve as an indicator, that data does not guarantee the same conditions at the measurement position.

Table 4 Favourable summertime weather conditions

| Parameter | Preferred condition |
|---|---|
| Ground cover | No snow, water, or ice (frozen) ground cover |
| Precipitation | No steady precipitation, monitoring invalid |
| Wind speed Measured at a height between 1.2 m and 10 m | <p>Wind speed limits (noise data may be invalid if limits are exceeded):</p> <p>Less than 500 m from noise source:</p> <p>Upwind: 10 km/hr limit Crosswind: 15 km/hr limit Downwind: 15 km/hr limit</p> <p>500–1,000 m from noise source:</p> <p>Upwind: 5 km/hr limit Crosswind: 10 km/hr limit Downwind: 10 km/hr limit</p> <p>Greater than 1,000 m from noise source:</p> <p>Upwind: less than 5 km/hr limit Crosswind: 10 km/hr limit Downwind: 10 km/hr limit</p> |
| <p>A 24-hour noise sampling period: unless exceptional circumstances are encountered, there must be at least three hours of valid data in the nighttime sampling period (10 p.m. to 7 a.m.) and three hours in the daytime sampling period (7 a.m. to 10 p.m.) If exceptional circumstances are encountered, the licensee must provide details of such circumstances and the reasons that these circumstances justify the use of a lesser amount of valid data.</p> | |

4.7 Noise survey

4.7.1 Methodology for assessing multiple noise sources

- (1) The methodology for assessment of multiple noise sources or isolation techniques relies on the judgment of an acoustical practitioner and must be documented in the noise investigation report.
- (2) Techniques that may be used:
 - 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 energy-related 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 (SPL) at a standard distance where each individual source is dominant.

- If the facilities are separated by some distance, 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 in close proximity to each other causing the sound fields to overlap, or if there are elevated sound sources that may not be adequately taken into account at the edge of the facility property due to vertical directionality of the sources, judgment must be used when assessing the sound levels (see Example 3, Appendix 6).
- (3) At points where two or more sources contribute to the total SPL, the relative contributions must be explained in the report.

For example, extensive near-field diagnostic surveys can be conducted at the various noise sources using computer-aided modeling to predict the source contributions at the dwelling.

4.7.2 Isolation analysis

- (1) Isolation analysis techniques are used to separate out sound sources and obtain the sound level from the source of interest alone.
- (2) During a CSL survey, all sound sources are captured for the survey period. However, in a compliance survey, noise contributions from the licensee's facility are evaluated.
- (3) Invalid or abnormal data not typical of an average ASL should be extracted from the measured CSL. Invalid data can include periods with unacceptable meteorological conditions or non-representative ground cover. Temperature inversions or lapse conditions¹ 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 dwelling. Such conditions affect the resident's perception of noise, but unless the event occurs with regularity due to local topography or other factors, the condition is dismissed. The extraction of data from the measured CSL must be documented, justified and supported by an acceptable reference, such as a digital or analog audio recording, operational log, or event log. The accumulated isolated facility contribution data must encompass the previously stipulated minimum time period.
- (4) Criteria for removing data may include:
- maximum wind speed exceeded;
 - measurement periods when precipitation is present;

¹ Temperature inversions or lapse conditions are defined as situations when temperatures in the atmosphere (usually measured at a height of 10 metres) are 1 C or more higher than at ground level (usually measured at a height of two metres).

- 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;
- abnormal noise events, including aircraft flyovers and off-plant site vehicular traffic; and
- other non-energy related sources of noise.

4.8 Comprehensive sound level survey report

Reports summarizing results of a noise survey used to show compliance with this rule must include the following information:

- 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,
- distance and direction of dwelling from the facility (include a map),
- record of calibration results,
- environmental conditions during monitoring period (wind speed and direction) and the source of the data,
- operating conditions for energy-related facilities included in the survey,
- graphs showing measured sound levels and any isolation analysis (with noise sources identified),
- summary table including the PSL for dwelling, measured sound level, isolation analysis results, and valid hours of the survey, and
- in cases where LFN was identified as a potential problem, the analysis and results.

4.9 Measurement

4.9.1 Instrumentation

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 (L_{eq}) of steady, intermittent, and fluctuating sounds. It must be able to accumulate the data and calculate the L_{eq} values over the time periods required and must meet the minimum technical specifications in the International Electrotechnical Commission (IEC) 61672-2 Ed.01.0 2003 (or latest version) for Type II sound level meters.

The sound measurement instrumentation necessary to conduct the one-third octave band sound pressure level measurements to characterize the presence of tonal components must meet the minimum technical specification in IEC publication 225-1966 or American National Standards Institute (ANSI) publication S1.11-1966 for Class II filter sets used in conjunction with conventional sound level meters that

meet the minimum technical specifications in IEC publication 651-1979 or ANSI publication S1.4-1983 for Type II sound level meters.

4.9.2 Calibrator certification requirements

Calibrators must be recertified in accordance with ANSI publication SI.40-1984 (or latest revision), which requires that a calibrator be recalibrated at least once a year.

4.9.3 Sound level meter calibration requirements

The sound level meters used for noise measurements made under this rule must:

- meet the requirements in ANSI S1.4-1983 and S1.4A-1985 or latest revision;
- be calibrated immediately prior to the measurement with a sound calibrator meeting the requirements of ANSI S1.40-1984 or latest revision;
- have their calibration confirmed immediately after the measurement using the same calibrator and a record of calibration results must be included in the report; and
- be calibrated by the instrument manufacturer, an authorized instrument calibration facility, or another agency acceptable to the Commission within a two-year period immediately preceding the measurements. Records of calibration must be maintained, although formal calibration certificates are not necessary. Meters which fail a pre-use or post-use calibration test (for example, the meter does not read within plus or minus one dB) must not be used until re-calibrated for accuracy, applicability, and cause of deviation. Data collected from noise meters that fail at pre-use or post-use field calibration test (i.e., the meter does not read within plus or minus one dB) must not be used.

4.9.4 Measurement techniques

General guidelines for sound measurement techniques are found in the following publications: Alberta Environment's A Method for Conducting and Reporting Noise Surveys at Industrial Plants, March 1978; Ontario Ministry of the Environment's Model Municipal Noise Control By-Law, 1978; ANSI publication S1.13-2005 (R2010): *Methods for the Measurement of Sound Pressure Levels in Air*; and International Organization for Standardization (ISO) Standard 1996, Parts 1,2 and 3 *Acoustics – Description, measurement and Assessment of Environmental Noise* (2003). Users must also ensure that the instrumentation is working within manufacturer's specifications and limitations.

5 Noise complaints and noise management plans

The Commission may conduct random CSL surveys of facilities. 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 Commission agrees that a CSL survey is not practical, a detailed noise management plan approved by the Commission may be used to demonstrate compliance for unique cases.

5.1 Noise management plans (NMP)

(1) An NMP must include:

- identification of noise sources;
- assessment of current noise mitigation programs;
- performance effectiveness of noise control devices;
- methods of noise measurement;
- best practices programs; and
- continuous improvement programs.

(2) In all cases, a NMP must be discussed with and incorporate input from all affected persons, such as nearby residents, regulated and non-regulated industries, and local government.

6 Construction noise

(1) Licensees must reduce the impact of construction noise on nearby dwellings. The following mitigating measures should be considered:

- conduct construction activity between the hours of 7 a.m. and 10 p.m. to reduce the duration impact of construction noise;
- advise nearby residents of significant noise-causing activities and schedule these events to reduce disruption to them; and
- ensure that all internal combustion engines are fitted with muffler systems.

(2) Should a noise complaint be filed during construction, the licensee must respond expeditiously and take action to ensure that the complaint has been addressed.

Appendix 1 - Glossary

Some of the terms used in this rule 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. |
| Acoustic practitioner | An acoustic practitioner is an individual with acoustical expertise and knowledge capable of preparing assessments, surveys and reports in accordance with this rule. |
| Ambient sound level (ASL) | <p>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 facilities 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 2. The ASL must be measured under representative conditions. As with comprehensive sound levels, representative conditions do not constitute absolute worst-case conditions (in this case, the quietest day) but conditions that portray typical conditions for the area. Also see <i>Representative conditions</i>.</p> <p>In the absence of measurement, the ASL is assumed to be five dBA less than the nighttime BSL or 5 dBA less than the BSL plus the daytime adjustment unless the applicant applies for an A2 Ambient Adjustment.</p> |
| 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 rule, transportation sources, animals, and nature. |
| Bands (octave, one-third octave) | <p>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.</p> <p>The one-third octave band analysis provides a finer breakdown of sound distribution as a function of frequency.</p> |

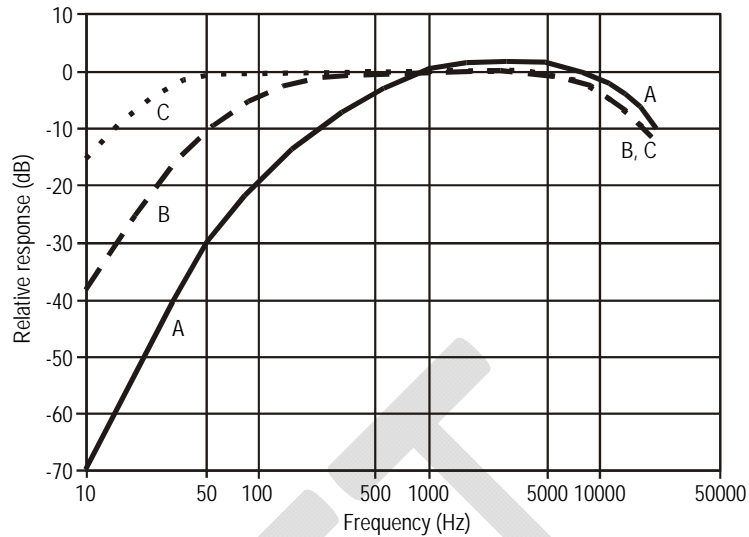


Figure 2 - Weighting network curves

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|-------------------------|---|
| Basic sound level (BSL) | The nighttime A-weighted L_{eq} 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 in relation to transportation routes used to arrive at a BSL. |
| Category 1 | Dwellings more than 500 metres from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers. Also see Category. |
| Category 2 | Dwellings more than 30 metres but less than 500 metres from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers. Also see Category. |
| Category 3 | Dwellings less than 30 metres 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. The Class A adjustment is added to the BSL, the daytime adjustment, and the Class B adjustment to arrive at the PSL. |

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| Class B adjustment | An adjustment applied for temporary noise generating activities which are activities lasting 60 or fewer days and occurring no more than once in any 12 month period. The adjustment 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 energy-related facilities and must be measured with them, but it should exclude abnormal noise events. The CSL is used to determine whether a facility is in compliance with Rule 012. Also see Representative conditions. |
| Cumulative noise level | The sound level that is the total contribution of all industrial noise sources (existing and proposed) from Commission-regulated facilities at the dwelling. |
| 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. |
| Daytime | Defined as the hours from 7 a.m. to 10 p.m.. |
| Daytime adjustment | An adjustment that allows a 10 dBA increase because 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 <i>dB</i> and <i>A-weighted sound level</i> . |

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| Deferred facility | Energy-related facilities constructed and in operation prior to October 1988. These facilities do not have to demonstrate compliance in the absence of a complaint. |
| Density per quarter section | Refers to a quarter section with the affected dwelling at the centre (a 451-metre radius). For quarter sections with various land uses or with mixed densities, the density chosen must be factored for the area under consideration. |
| Dwelling | <p>Any permanently or seasonally occupied dwelling including a nursing home or hospital with the exception of an employee or worker residence, dormitory, or construction camp located within an energy-related industrial plant boundary. Trailer parks and campgrounds may qualify as a dwelling if it can be demonstrated that they are in regular and consistent use during the applicable season.</p> <p>The nearest dwelling may not necessarily be the one most adversely affected because of factors such as topography or man-made features. For example the nearest dwelling to a facility may be behind an intervening ridge, while a more distant dwelling may be in direct line of sight of the facility. Therefore, the rule refers to the nearest or the most impacted dwelling for purposes of determining the PSL.</p> |
| Emergency | An unplanned event requiring immediate action to prevent loss of life or property. Events occurring more than four times a year are not considered unplanned. |
| Energy equivalent sound level (L_{eq}) | <p>The L_{eq} 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 L_{eq}—e.g., $L_{eq}(9)$ is a nine-hour L_{eq}. If a sound level is constant over the measurement period, the L_{eq} 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.</p> $L_{eq} = 10 \log \left(\sum_{i=1}^n f_i \times 10^{L_i/10} \right)$ <p>See Appendix 2 for more detail on the L_{eq} concept.</p> |
| Energy-related facility | A facility, other than a facility under the jurisdiction of the Commission, used for energy generation, transport (except by road) and resource extraction. These include the mining, extraction, processing and transportation (except by road) as well as federally regulated electrical transmission lines. |
| Facility property | The facility property is used to establish the 1.5 km compliance distance from a facility. The boundary of the facility property is defined |

by the legal interest in the land (i.e, property line, right of way, easement or lease). Lands optioned for future developments or for wind power projects may not be used to define the boundary.

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| Far field | <p>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.</p> <p>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 (six 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.</p> |
| 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 NEF 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 five 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 | Includes highways and any other road where 90 or more vehicles travel during the nine-hour nighttime period. |
| 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. |
| L_{eq} | 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.

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| Near field | The region close to the source where the inverse-square law (six 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 p.m. to 7 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 | A noise impact assessment identifies the expected sound level emanating from a facility as measured 15 metres from the nearest or most impacted permanently or seasonally occupied dwelling. It also identifies what the permissible sound level is and how it was calculated. |
| Permanently occupied dwelling | A fixed residence occupied on a full-time basis. |
| Permissible sound level (PSL) | The maximum daytime/nighttime sound level that a facility must not exceed at a point 15 metres from the nearest or most impacted dwelling. The PSL is the sum of the BSL, daytime adjustment, 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. |
| Proposed facility | A proposed facility is a facility for which an application has been submitted but is not yet approved or for which an approval has been issued but is not yet constructed. |
| 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).

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|---|---|
| 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 one 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. |
| Sound power level (PWL, SWL, or L_w) | <p>The decibel equivalent of the rate of energy (or power) emitted in the form of noise. The sound power level is given by:</p> $\text{Sound Power Level} = 10 \log \left(\frac{\text{sound as power (watts)}}{W_0} \right)$ <p>By international agreement, $W_0 = 10^{-12}$ watts (W)</p> <p>However in some older data (roughly pre-1975), the value of W_0 was set as 10^{-13} W (no longer used). The sound power level is an inherent property of a noise source.</p> |
| Sound pressure level (SPL or 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. |

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, one-third 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 one-third octave bandwidths. In addition, there must be a minimum of a five-dBA drop from the band containing the tone within two 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 6.

Wind turbine

A machine for converting the kinetic energy in wind into mechanical energy, which is then converted into electricity.

Wintertime conditions

There is snow, ice, or frozen ground cover and temperatures are below 0 C.

DRAFT

Appendix 2 - Sound level descriptors

2.1 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 Appendix 1: Glossary for A-weighted sound level and Figure 2 Weighting network curves).

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.

2.2 L_{eq} Concept

This rule uses L_{eq} measurements, which represent energy-equivalent sound levels. The L_{eq} 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 L_{eq} (e.g., $L_{eq}(9)$ is a 9-hour L_{eq}). If a sound level is constant over the measurement period, the L_{eq} will equal the constant sound level. Figure 3 illustrates this concept.

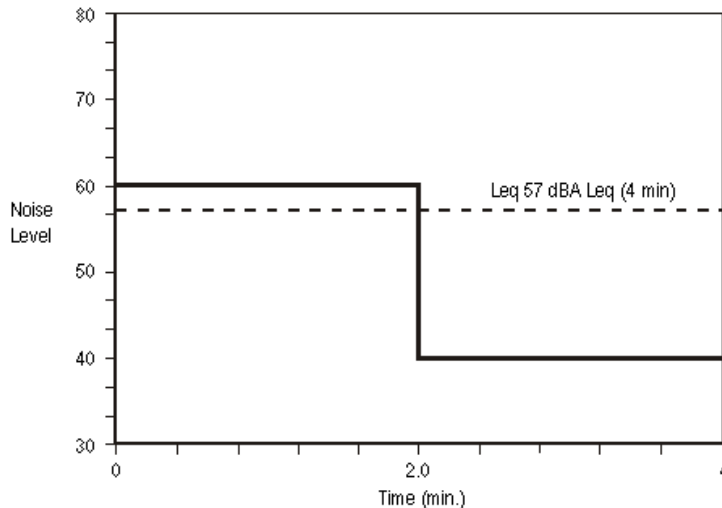


Figure 3 - Illustration of L_{eq} concept

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:

$$\begin{aligned}
L_{eq} &= 10 \log \left(\sum_{i=1}^n f_i \times 10^{L_i/10} \right) \\
&= 10 \log \left(\sum_1^{240} f_i \times 10^{L_i/10} \right) \\
&= 10 \log \left(\frac{120}{240} \times 10^{60/10} + \frac{120}{240} \times 10^{40/10} \right) \\
&= 10 \log (505\,000) \\
&= 57 \text{ dBA } L_{eq} (4 \text{ min})
\end{aligned}$$

where: f_i = fraction of total time the constant level L_i is present

L_i = sound level in dBA

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 L_{eq} calculation is useful in demonstrating how a loud noise event, such as a train passing by, can alter the L_{eq} 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:

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

This example demonstrates how loud noise events, such as trains passing, can dominate the L_{eq} values.

2.3 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 modeling 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:

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

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 five 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 one-third 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: ($Q_s \approx 5 - 8$).

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 | 1/8-spherical | In a corner of three surfaces |

2.4 Addition of sound power or sound pressure levels

A similar formula to the one used in section 2.2, L_{eq} Concept, 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).

The formula for the addition of sound levels is:

$$L_{total} = 10 \log(10^{L_1/10} + 10^{L_2/10} + \dots + 10^{L_n/10})$$

where L_i = individual component sound levels (power or pressure).

Example calculation of addition of sound power levels

You are building a simple facility and are told by the manufacturer that the A-weighted sound power levels (referred to as 10^{-12} watts, also written 1 picowatt, or 1 pW) for the different components are as follows:

Engine exhaust, with muffler 106 dBA
Aerial cooler (nondirectional) 113 dBA
Piping noise 79 dBA

$$\begin{aligned}L_{power, total} &= 10 \log(10^{L_1/10} + 10^{L_2/10} + \dots + 10^{L_n/10}) \\ &= 10 \times \log_{10} (10^{106/10} + 10^{113/10} + 10^{79/10}) \\ &= 10 \times \log_{10} (10^{10.6} + 10^{11.3} + 10^{7.9}) \\ &= 10 \times \log_{10} (2.394 \times 10^{11}) \\ &= 10 \times 11.38 \\ &= 113.8 \text{ dBA (ref 1 pW)}\end{aligned}$$

When adding sound pressure levels, these levels are only valid for the specific location. To add the sound pressure levels, they must all be calculated or measured at the same location.

2.5 Estimate of sound pressure levels for different distances

2.5.1 Point sources

This estimate assumes hemispherical spreading of the sound waves and equates to a six-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:

- 1) 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 property.
- 2) 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 metres can be used as a rule of thumb.
- 3) The inverse square law (six-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 Appendix 2 and Section 2.3, *Sound power and sound pressure levels*, can be used instead.

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

The basic equation is:

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

with 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 six dB.

Example calculation of determining the sound level at a different distance

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

You know that $L(50 \text{ m}) = 75 \text{ dBA}$.

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

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

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

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

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

So the sound level contribution due to the compressor is 51 dBA at 800 metres.

A simpler, more intuitive way to do the calculation is illustrated below.

Alternative method of determining the sound level at a different distance — the simple table approach

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

If we use the 75 dBA at 50 metre 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 metres. 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.

2.5.2 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 Appendix 2, section 2.3 and Section 2.5.1 can be used.

For a line source, the sound spread equates to a three-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:

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

with R_1 = distance R_1 , in metres
 R_2 = distance R_2 , in metres, and
 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 - Noise Impact Assessment Summary Form



Licensee: _____

Facility name: _____ Type: _____

Legal location: _____

Contact: _____ Telephone: _____

1. Permissible sound level (PSL) determination (Rule 012, Section 2)

(Note that the PSL for a pre-1988 facility undergoing modifications is the equivalent noise level (L_{eq}) that currently exists at the dwelling if no prior noise complaint exists and the current sound level L_{eq} exceeds the calculated PSL from Section 2.1.)

Complete the following for the nearest or most impacted dwelling(s):

| Distance from facility | Direction from facility | BSL (dBA) | Daytime adjustment (dBA) | Class A adjustment (dBA) | Class B adjustment (dBA) | Nighttime PSL (dBA) | Daytime PSL (dBA) |
|------------------------|-------------------------|-----------|--------------------------|--------------------------|--------------------------|---------------------|-------------------|
| | | | | | | | |
| | | | | | | | |

2. Sound source identification

For the new and existing equipment, identify major sources of noise from the facility, their associated sound power level (PWL) or sound pressure level (SPL), the distance (far or free field) at which it was calculated or measured, and whether the sound data are from vendors, field measurement, theoretical estimates, etc.

| New Equipment | Predicted | or | Measured | Data source | Distance calculated or measured (m) |
|---------------|--|----|--|-------------|-------------------------------------|
| | <input type="checkbox"/> PWL (dBA) <input type="checkbox"/> SPL (dBA) | | <input type="checkbox"/> PWL (dBA) <input type="checkbox"/> SPL (dBA) | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| Existing Equipment/Facility | Predicted | or | Measured | Data source | Distance calculated or measured (metres) |
|-----------------------------|--|----|--|-------------|--|
| | <input type="checkbox"/> PWL (dBA) <input type="checkbox"/> SPL (dBA) | | <input type="checkbox"/> PWL (dBA) <input type="checkbox"/> SPL (dBA) | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

3. Operating conditions

When using manufacturer's data for expected performance, it may be necessary to modify the data to account for actual operating conditions (for example, indicate conditions such as operating with window/doors open or closed). Describe any considerations and assumptions used in conducting estimates:

4. Modeling parameters

If modeling was conducted, identify the parameters used (see section 3.5 (1)):

(continued)

5. Predicted sound level/compliance determination

Identify the predicted overall (cumulative) sound level at the nearest or most impacted dwelling. Typically, only the nighttime sound level is necessary, as levels do not often change from daytime to nighttime. However, if there are differences between day and night operations, both levels must be calculated.

Predicted sound level to the nearest or most impacted dwelling from new facility (ASL + new facility + existing energy-related facilities):

_____ dBA (night) Permissible sound level: _____ dBA (night)

If applicable: _____ dBA (day) Permissible sound level: _____ dBA (day)

Is the predicted sound level less than the permissible sound level? Yes _____ No _____

If **YES**, go to number 7.

6. Compliance determination/attenuation measures

(a) If 5 is **NO**, identify the noise attenuation measures the licensee is committing to:

Predicted sound level to the nearest or most impacted dwelling from the facility (ASL + new facility **with** noise attenuation measures + existing energy-related facilities):

_____ dBA (night); if applicable: _____ dBA (day)

Is the predicted sound level less than the permissible sound level? Yes _____ No _____

If **YES**, go to Number 7.

(b) If 6 (a) is **NO** or the licensee is not committing to any noise attenuation measures, the facility is not in compliance. If further attenuation measures are not practical, provide the reasons why the measures proposed to reduce the impacts are not practical.

7. Explain what measures have been taken to address construction noise.

8. Acoustical practitioner's information (See Section 3.8 (9)):

Company: _____

Title: _____

Telephone: _____ Date: _____

Appendix 4 - Noise Complaint Investigation Form



PART 1

Date (D/M/Y): _____

Resident: _____

Licensee representative: _____

Legal location: _____

Licensee: _____

Address: _____

Address: _____

Telephone: _____

Telephone: _____

Noise characterization

Identify the quality and characteristics of the noise.

Distance to source: _____ (m) When is noise a problem (day/night)? _____

Pitch (high/low): _____ Where is noise most annoying (inside/outside)? _____

Is there a noticeable tone? _____ Describe: _____

Is noise steady/intermittent/pulsating? _____ Describe: _____

Is the noise heard and/or a vibration felt? _____ Describe: _____

What is noise comparable to? _____

Other comments: _____

Weather conditions

Identify the weather conditions under which the noise is most noticeable.

Temperature: _____ Direction wind is coming from: _____

Wind speed (km/h): _____ Cloud cover: _____ Precipitation: _____

Ground cover between dwelling and facility (snow, water, grass, crop, trees, ice, etc.):

Other comments: _____

Representative conditions

From the above, identify the conditions that should exist as closely as possible during a comprehensive sound level survey.

(continued)

Appendix 5 - Determination of low frequency tonal component

5.1 The methodologies

The methodologies shown below are intended as guidelines only and should not restrict the methods of an acoustical practitioner. The Commission will review the proposed methodology and approve the techniques or require other methods, as deemed appropriate. As the 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 issue 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 issue is intermittent or continuous.

5.1.1 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 one-third octave L_{eq} and statistical levels (L_{10} , L_{50} , L_{90} , or some combination). The difference in the L_{eq} (equivalent-continuous) levels for adjacent spectral bands should be graphed in order to demonstrate whether there is a pure tone, as defined in Section 4.2. 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.

5.1.2 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 L_{eq} or a “slow” weighted sound level. Many instruments do allow simultaneous measurements of the one-third octave L_{eq} levels. If meters cannot track all the one-third octave frequency bands at the same time, the tonal components can be assessed by running a 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 one-third octave band settings until all bands between 20 and 250 Hz have been analyzed.

5.1.3 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 metres to 10 metres above ground in the vicinity of the sound monitoring location(s) based on the professional judgment of the acoustical practitioner. 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 dBA within two bandwidths on one side and five dBA or greater drop within two bandwidths on the other side, in addition to being pronounced within the spectrum).

| Band (Hz) | Sound level (dB) | Part 1 | | Part 2 |
|-----------|------------------|---|----------------------------|--------------------------------|
| | | 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 |

Figure 4 - one-third octave band frequency spectrum analysis for tonal components

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 dBA within two bandwidths on one side and five dBA or greater drop within two bandwidths on the other side); however, the second is at a frequency greater than 250 Hz and would not be considered low frequency noise.

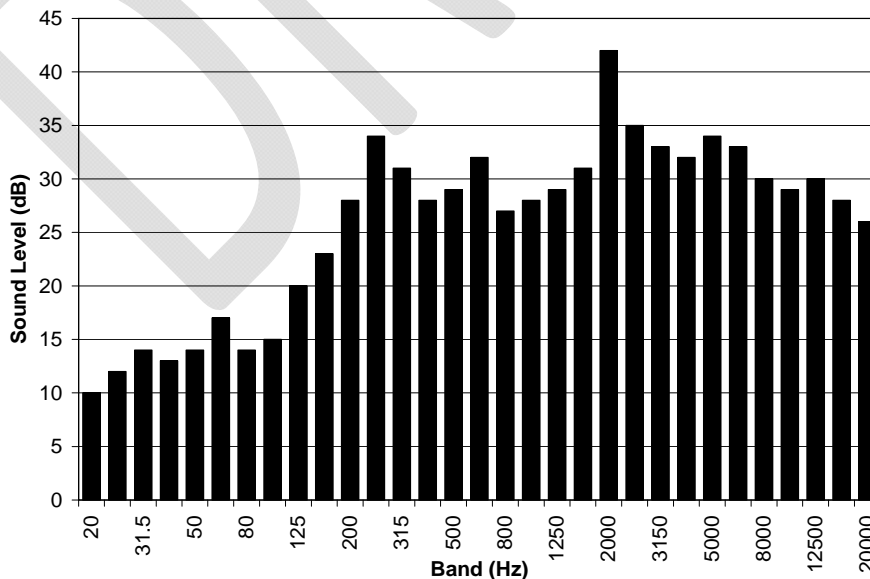


Figure 5 - one-third octave band centre frequency (Hz)

Figure 5 - one-

Appendix 6 - Examples

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

Example 1 — PSL determination

A new facility is proposed for the area shown in Figure 6. What sound levels should the facility be designed for?

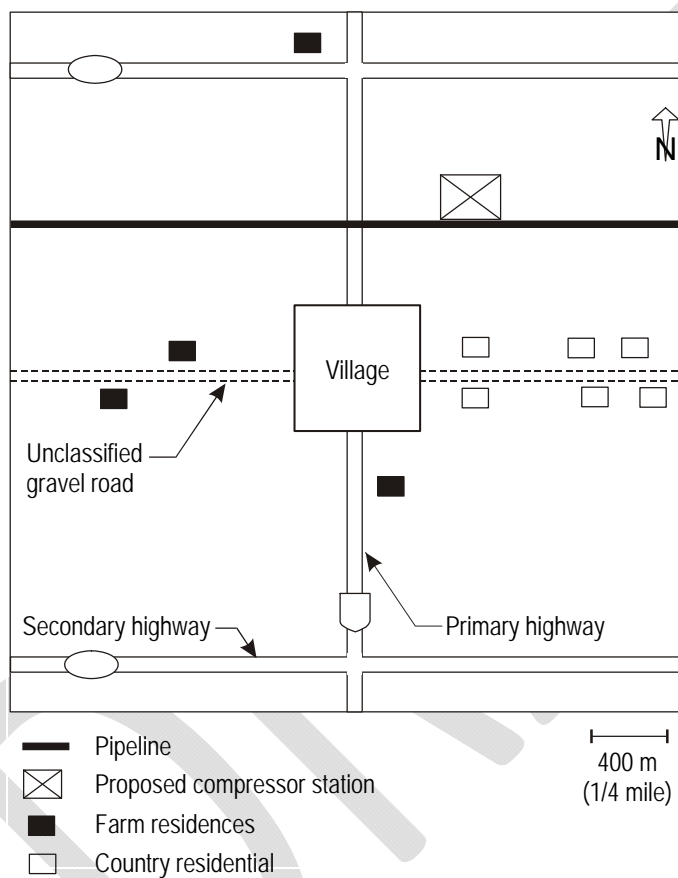


Figure 6 - Area sketch for example 1

Example 1 – Solution

Step 1 Designing a new facility. Determine PSL.

All three possible dwelling densities are represented in this area. The four 8.1 ha (20 acre) country residential dwellings factored over a quarter section fall into the one to eight dwellings range, as do the farmhouses. The two country residential dwellings closest to the village and a portion of the village are in the nine to 160 dwellings range, while the body of the village is in the greater than 160 dwellings range.

Regarding the transportation proximity category: the presence of the primary highway causes the adjacent farmhouses to fall into category 2, while the

dwellings in the village fall into category 2 or category 3, depending on the distance from the highway. Some of the country dwellings fall into category 2 (those closest to the highway), while others fall into category 1 (farther along the gravel road). The farmhouses on the gravel road are category 1.

It appears that the country dwellings to the south of the proposed facility are probably the most sensitive, being category 1 dwellings. This gives a nighttime BSL of 40 dBA L_{eq} , from Table 1.

Some preliminary calculation of expected sound levels and attenuation may be useful in determining the most impacted dwelling. For instance, the nearest dwelling may be a category 2, while a more distant 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 non-regulated noise source in area (feedlot that operates 24 hours). The licensee of this proposed facility has taken some spot measurements with a hand-held sound meter. The levels recorded ranged from 35 dBA at night to 55 dBA during the day. Consult with the Commission and obtain approval for using the A2 adjustment.
- Step 5 A 24-hour ambient sound monitoring study 15 metres from the nearest acreage dwelling prior to construction of the facility must be conducted to claim adjustment A2. The results of the survey are
- | | |
|----------------|-----------------|
| Daytime ASL: | 53 dBA L_{eq} |
| Nighttime ASL: | 37 dBA L_{eq} |
- After receiving approval for using the A2 adjustment. Claim adjustment A2 from Figure 1. First, subtract the ASL measured in this step from the BSL in step 2.
- | | |
|---------------------------------|---------------|
| 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 L_{eq} |
| Nighttime adjustment: | A2 = +2 dBA L_{eq} |
- Step 6 Sum of adjustments: A1 + A2 (call it A)
- | | |
|------------|------------------------|
| Daytime: | 0 + 8 = 8 dBA L_{eq} |
| Nighttime: | 0 + 2 = 2 dBA L_{eq} |
- Step 7 Is A greater than 10 dBA L_{eq} ?
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 facility will operate all year.
 Class B adjustment: B = 0 dBA

Step 9 Determine the PSL (PSL).

| Daytime | | | | | Nighttime | | | | | | |
|-----------------------|---|-----|-------|-----|-----------|-----------------------|---|------|-------|-----|-----|
| PSL | = | BSL | + Day | + A | + B | PSL | = | BSL | + Day | + A | + B |
| PSL | = | 40 | + 10 | + 8 | + 0 | PSL | = | + 40 | + 0 | + 2 | + 0 |
| PSL = 58 dBA L_{eq} | | | | | | PSL = 42 dBA L_{eq} | | | | | |

Step 10 Daytime PSL = 58 dBA L_{eq}
 Nighttime PSL = 42 dBA L_{eq}
 as measured 15 metres from the nearest acreage dwelling .

Example 2— Simple source noise impact assessment

A new facility is proposed for the area shown in Figure 7. What is the predicted sound level at the nearest or most impacted dwelling?

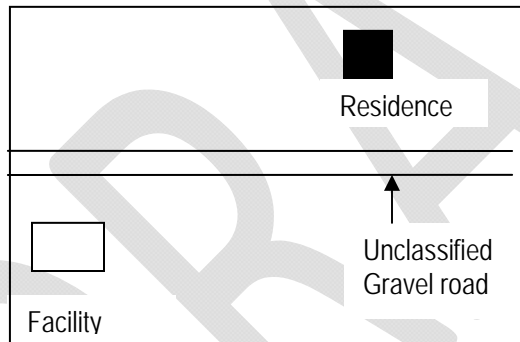


Figure 7 - Area sketch for example 2

Example 2 - Solution

The designer must calculate the maximum sound output of the facility. In this case, for example, the dwelling is about 600 metres from the facility. Assuming a theoretical six-dBA drop in sound level per doubling of distance, the facility must have a sound level of no more than 60 dBA L_{eq} measured 75 metres from the facility in order to have a sound level of 42 dBA at 600 metres. This can be seen from the following table:

| Distance (m) | Sound Level (dBA) |
|--------------|-------------------|
| 600 | 42 |
| 300 | 48 |
| 150 | 54 |
| 75 | 60 |

Note that since this is a small, stationary, single-source facility without any existing energy-related industrial infrastructure and with flat ground between the facility and a single dwelling at a close distance, the six-dBA loss per doubling of distance is used.

The six-dBA loss per doubling of distance is a very rough estimate, and more site-specific methods should be used if possible. A more accurate way to determine the sound attenuation with distance is to measure similar equipment at a topographically similar location. This is done by measuring the sound levels at specified distances away from the facility (for example, 100 metres, 200 metres, 400 metres, etc.) to determine the actual attenuation with distance. It is not uncommon for this attenuation to vary between five dBA and 10 dBA for each doubling of distance.

For a design situation, notice how it is the nighttime sound level that must be met. Most permanent facilities create the same amount of noise whether it is day or night, and so the most stringent criterion is the nighttime sound level.

The noise impact assessment developed from these findings would include the following:

- 1) 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 metres in front of the cooler fan.
- 2) The sound levels at the nearest dwelling have been predicted using only the theoretical six-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 metres.
- 3) The distance to the most impacted dwelling is 600 metres to the south. This also happens to be the closest dwelling. If we extrapolate the 60 dBA value out to 600 metres, using the theoretical six-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 this to the typical rural ambient sound level (35 dBA L_{eq}) would give a combined predicted sound level of 40.0 dBA L_{eq} .

As well, we have measurements at a similar facility with similar topography to the one being applied for. Those measurements indicate short-term sound levels of 55 dBA to 60 dBA at a distance of 75 metres. These measurements indicate that the six-dBA loss per doubling of distance may be conservative. As another measure to ensure compliance of the facility, the cooler fan will be faced in a southwest direction, so that dwellings are not located in front of it.

- 4) 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 one to eight 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 L_{eq} nighttime.
- 5) 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 indicates that the facility will meet the requirements in this rule. If the facility receives any complaints, they will be investigated promptly, and if the facility is not meeting the rule's requirements, remedial action will be undertaken to rectify the situation and bring the facility into compliance with this rule.

- 6) No further attenuation measures need to be considered at this time.
- 7) This noise impact assessment was conducted by acoustical practitioner, of XYZ Company. Also see other requirements set out in section 3.8 (9).

Example 3—Cumulative effects assessment

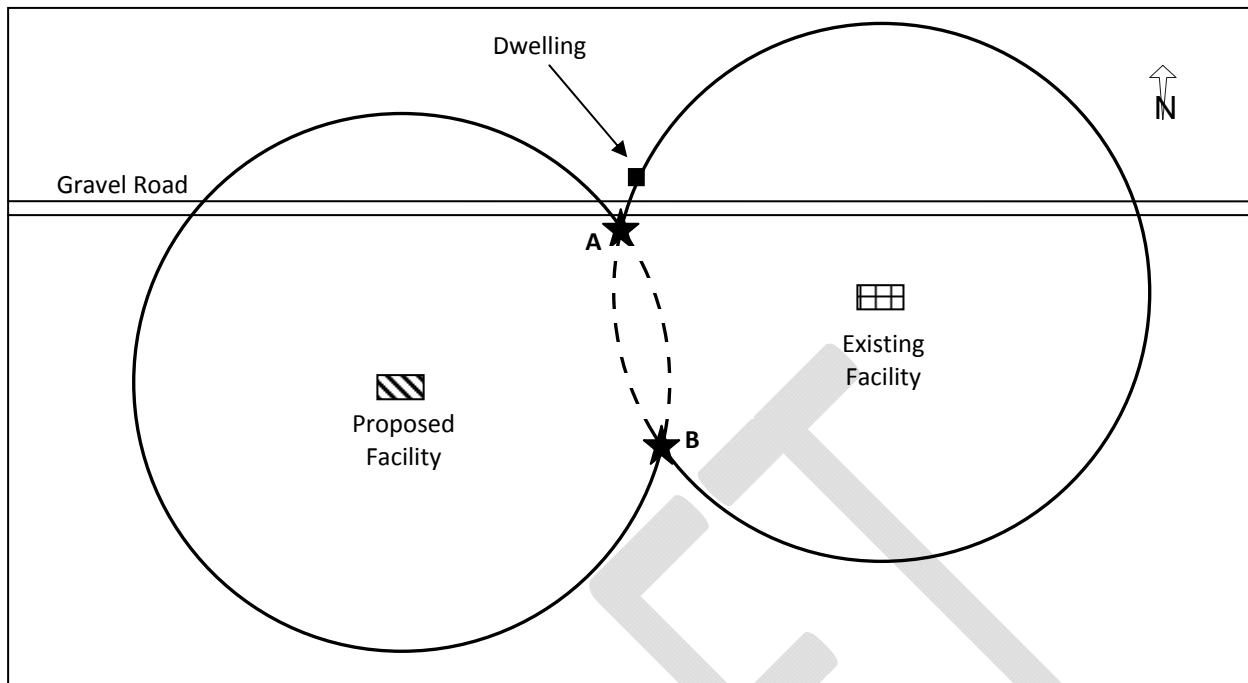
A new facility is proposed for the area shown in Figure 8. For what location(s) should compliance be determined? How should the existing energy-related facility be considered?

Two concepts for addressing cumulative effects are presented as scenarios 3A and 3B below:

3A: A proposed single-source facility that does not contribute to noise levels at a distance of 1.5 km from the facility property nor at an occupied dwelling in the study area.

3B: A proposed multi-source facility that does contribute to noise levels at a distance of 1.5 km from the facility property, possibly affecting an occupied dwelling in the study area.

The concepts presented are not the only ways that cumulative effects may be considered in a noise impact assessment. The best approach would vary on a case-by case basis, as determined by the acoustical practitioner.



Legend

- 1.5 km distance from facility fence line
- - - Overlapping area
- ★ 1.5 km radii intersection points

Figure 8 - Area sketch showing the 1.5 km distances for facility properties in example 3

Scenario 3A

The new facility is proposed for an area where there is an existing energy-related facility. The gravel road next to the occupied dwelling in the study area is not heavily travelled.

The acoustical practitioner must assess cumulative effects of noise at potentially-affected occupied dwellings or at a distance of 1.5 km from the facility property if there are no dwellings affected by noise from the proposed facility.

In this example, compliance of the proposed facility is demonstrated by showing that there is no increase in sound level (no net increase) above the existing noise level (which includes the noise level of the existing facility) with the addition of the proposed facility at a distance of 1.5 km which, in turn, demonstrates there is no effect at the existing occupied dwelling.

Assuming that there is no noise data available, and there is no formal noise complaint registered from the occupant of the dwelling, the existing facility is assumed to be compliant with the PSL of 40 dBA L_{eq} nighttime and 50 dBA L_{eq} daytime at a distance of 1.5 km from the facility property (which is also the distance to the occupied dwelling). The cumulative sound level including the proposed facility cannot exceed the PSL at the two points (A and B) where the two-facility 1.5 km distance radii intersect. The PSL within the overlapping portion of the 1.5 km distance would not be assessed.

Scenario 3A – Approach

- 1) The PSL at the distance of 1.5 km from the proposed facility property is 40 dBA L_{eq} nighttime and 50 dBA L_{eq} daytime per Section 2.1 of Rule 012.
- 2) The sound emission from the proposed facility needs to be determined. Measurements from a similar facility indicate that this type of single noise source emits 57 dBA measured at a distance of 25 metres from the fence line.
- 3) Contribution of the proposed facility is then determined. Using the simplified distance attenuation formulae (Appendix 2, Section 2.5; note that the required conditions are met), a sound level of 57 dBA at 25 metres results in a noise contribution at points A or B in Figure 8 of 21 dBA. Theoretical assessment based on engineering estimates and manufacturer's data are also acceptable. For more complex noise sources or situations, the acoustic practitioner must use more detailed calculations or acoustic modeling software.
- 4) Theoretical cumulative effects assessments consider the noise contributions of all energy-related facilities plus the contribution of the assumed ASL from AUC Rule 012, Section 2.1. The existing facility in Figure 8 is assumed to be compliant so that it meets the PSL of 40 dBA L_{eq} at 1.5 km. This means the existing facility contribution at 1.5 km is 38 dBA, with an ASL of 35 dBA.
- 5) Compliance of the proposed facility is assessed at the points of intersection of the 1.5 km distance radii (see points A and B in Figure 8). Noise levels of the existing facility, proposed facility and assumed ASL at the point of analysis are summed. In this example, the predicted sound level is:

$$\text{Proposed Facility} + \text{Existing facility} + \text{Assumed ASL} = \text{dBA } L_{eq} \text{ at Points A or B}$$

which is

$$21 \text{ dBA} + 38 \text{ dBA} + 35 \text{ dBA} = 40 \text{ dBA at Points A or B}$$

As point A is nearest to the occupied dwelling affected by the existing facility, compliance at point A will also mean, in this example, compliance at the occupied dwelling.

- 6) The predicted noise level in this example demonstrates compliance with the PSL of 40 dBA L_{eq} nighttime with the proposed facility also demonstrating a no net increase in noise level.
- 7) The noise impact assessment supplied for this example must contain the details required according to AUC Rule 012 Section 3, including the assumptions made, data sources and formulae used.

Scenario 3B

In this example, a comprehensive sound level (CSL) measurement was conducted at the occupied dwelling, to evaluate the existing noise level of the existing facility. The occupied dwelling is at a distance of 1.8 km, which is beyond the 1.5 km distance from the proposed facility property.

Unlike approach A where compliance with the PSL of the existing facility was the assumed, in this example a valid comprehensive noise measurement provides the actual sound level experienced at the occupied dwelling. Also unlike Scenario A where the facility was a single noise source, in this scenario, the proposed facility consists of multiple noise sources.

Scenario 3B – Approach

- 1) The PSL at the occupied dwelling is established based on a Category 1 dwelling density and the absence of heavily travelled transportation routes as discussed in Rule 12, Subsection 2.1(3). The PSL at both the dwelling and the distance of 1.5 km from the facility property of the proposed facility is 40 dBA L_{eq} nighttime and 50 dBA L_{eq} daytime.
- 2) The isolated contribution to noise from the existing facility, according to the CSL survey, conducted under representative conditions, indicated a nighttime noise level of 39.2 dBA L_{eq} and a daytime noise level of 46.1 dBA L_{eq} . The representative, isolated noise levels include data collected when the dwelling was downwind of the existing facility and excludes isolated noise events (an operating lawnmower and a dog barking near the instrument). The facility was confirmed to be operating normally. These measurements represent the cumulative value of the existing facility contribution and the existing ASL.
- 3) An acoustic model of the proposed facility has been developed using a combination of manufacturer and theoretical data for the proposed facility. The calculations were conducted according to the ISO 9613 standard. Results from the acoustic model indicate the proposed facility will contribute 32.3 dBA L_{eq} nighttime at a distance of 1.5 km and 30.1 dBA L_{eq} nighttime at the occupied dwelling at a distance of 1.8 km.
- 3) Compliance of the proposed facility is assessed at the points of intersection of the 1.5 km distance radii (see points A and B in Figure 8) and at the potentially-affected occupied dwelling. Compliance is determined by adding the proposed facility contribution to the existing facility contribution for both the 1.5 km distance and at the occupied dwelling, then comparing the results to the PSL:
$$\text{Proposed Facility} + \text{Measured Existing Facility (including ASL)} = \text{dBA } L_{eq}$$
$$\text{For point A or B: } 32.3 \text{ dBA} + 39.2 \text{ dBA} = 40.0 \text{ dBA } L_{eq} \text{ nighttime}$$
$$\text{For the dwelling: } 30.1 \text{ dBA} + 39.2 \text{ dBA (nighttime)} = 39.7 \text{ dBA } L_{eq} \text{ nighttime}$$
$$\text{For the dwelling: } 30.1 \text{ dBA} + 46.1 \text{ dBA (daytime)} = 46.2 \text{ dBA } L_{eq} \text{ daytime}$$
- 4) The noise impact assessment supplied for this scenario provided the details required according to Section 3 of Rule 012, including the assumptions made and data sources or formulae used.

Appendix 7 - Standards

| Standard | Latest Revision | Description |
|---|--|---|
| ANSI SI.1-1960 (RI976) | ANSI S1.1-1994 (R2004) | ACOUSTICS An Introduction to Its Physical Principles and Applications, Allan Pierce (renamed Acoustical Terminology) |
| ANSI SI.11-1986 (RI993) | ANSI S1.11-2004 | Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters |
| ANSI S1.40-1984 | ANSI S1.40-2006 | American National Standard Specifications and Verification Procedures for Sound Calibrators |
| ANSI S1.4A-1985 | ANSI S1.4-1983 (R2006)/ANSI S1.4a-1985 (R2006) | American National Standard Specification for Sound Level Meters |
| ANSI S1.4-1983 | | |
| ANSI SI.26-1978 | ANSI S1.26-1995 (R2004) | Method for the Calculation of the Absorption of Sound by the Atmosphere |
| ANSI S1.13-2005 | ANSI S1.13-2005 | Measurement of Sound Pressure Levels in Air |
| ASTM Designation E1014-84 (reapproved 2000) | ASTM E1014 - 08 | Standard Guide for Measurement of Outdoor A-Weighted Sound Levels |
| ISO 1996-1 (2003) | ASTM E1686 - 03 | ASTM E1686 - 03 Standard Guide for Selection of Environmental Noise Measurements and Criteria |
| ISO Standard 9613 | ISO 9613-1:1993 and ISO 9613-2:1996 | Attenuation of sound during propagation outdoors – Part 1 Calculation of the Absorption of Sound by the Atmosphere; and Attenuation of sound during propagation outdoors – Part 2 General method of calculation |
| IEC 651-1979 | Replaced by IEC 61672-1 Ed. 1.0, 2002 | Electroacoustics – Sound Level meters Part 1: Specifications |
| IEC 225-1966 | Replaced by IEC 61260 :1995 Amended 2001 | Electroacoustics – Octave Band and fractional-octave-band filters |
| IEC 61672-2 Ed.01.0 2003 | IEC 61672-2 Edition 1.0 (2003) | Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests |
| CSA Z107.0-1984 | | Definitions of Common Acoustical Terms used in CSA Standards |
| CSA Z107.55 – M1986 | CAN/CSA-Z107.55-M86 (R2001) | Recommended Practice for the Prediction of Sound Levels Received at a Distance from an Industrial Plant |