DRAFT (dated Dec 23, 2011)

Rule 012

Noise Control

The Alberta Utilities Commission (AUC or the Commission) has approved amendments to this rule on Month xx, 2011 which are effective on April 1, 2012

Contents

List of Tables

List of Figures

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*

(d) "hydro development", "power plant", "substation" or "transmission line" has the same meaning as in the *Hydro and Electric Energy Act*

(e) "licensee" means the holder of a licence or approval for a facility in accordance with the records of the Alberta Utilities Commission

Refer to Appendix 1- Glossary for additional definitions.

1.2 Rule application

(1) The purpose of this rule is to ensure that noise from a facility, cumulatively with other noise from energy-related facilities, does not exceed the permissible sound level calculated in accordance with this rule.

The rule provides a process to evaluate noise complaints relating to a facility.

(2) Subject to Section 2.2, this rule applies to:

- an existing or proposed facility, the operation of a facility and noise related to construction of a facility; and
- all applications filed on or after April 1, 2012.

(3) The rule in force prior to January 1, 2012, continues to apply to applications filed before April 1, 2012.

1.3 Compliance

At any dwelling, the permissible sound level determined in accordance with Section 2 of this rule must not be exceeded.

1.4 Commission discretion

(1) The Commission retains the discretion to assess the permissible sound level on a site specific basis and may permit a permissible sound level in excess of the permissible sound level determined in Section 2.

(2) The Commission retains the discretion to conduct random comprehensive sound level surveys of facilities.

2 Permissible sound level

2.1 Determination of permissible sound level

(1) The permissible sound level is determined for the most impacted dwelling(s) from the boundary of the facility property and is the value assigned to that dwelling, or if there are no dwellings within 1.5 kilometres (km) from the facility property, then the permissible sound level of 40 dBA L_{eq} nighttime is applicable at 1.5 km from the facility property. The permissible sound level is based on summertime conditions.

(2) In the case of an emergency, which is an unplanned event requiring immediate action to prevent loss of life or property, the permissible sound level determined under this rule does not apply. However, if an event occurs more than four times a year at a facility, the event is not considered an unplanned event and the facility must comply with its permissible sound level.

(3) A dwelling may have only one nighttime and one daytime permissible sound level.

(4) The permissible sound level is calculated as follows:

Permissible sound level	=	Basic sound level (Table 1)	+	Daytime adjustment (Item (6) below)	+	Class A adjustment (Table 2)	+	Class B adjustment (Table 3)

(5) Nighttime basic sound levels are determined from Table 1. The minimum basic sound level used to calculate the permissible sound level is 40 dBA L_{eq} nighttime with adjustments made for proximity to transportation and population density as indicated in Table 1.

Table 1. Basic sound levels for nighttime*

	Dwelling density per quarter section of land		
(1) **Proximity to transportation**	**(2)** **1 - 8 dwellings; 22:00 - 07:00 (nighttime) (dBA L_{eq})**	**(3)** **9 - 160 dwellings; 22:00 - 07:00 (nighttime) (dBA L_{eq})**	**(4)** **>160 dwellings; 22:00 - 07:00 (nighttime) (dBA L_{eq})**
Category 1	40	43	46
Category 2a	42	45	48
Category 2b	45	48	51
Category 3	50	53	56

*Notes:

(1) The assumed nighttime ambient sound level is five dBA less than the applicable basic sound level.

(2) The assumed daytime ambient sound level is five dBA less than the applicable basic sound level plus the daytime adjustment.

(3) Category 1—dwellings distance is more than or equal to 500 m from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers.

(4) Category 2a—dwellings distance is more than or equal to 160 m, but less than 500 m from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers.

(5) Category 2b—dwellings distance is more than or equal to 30 m, but less than 160 m from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers.

(6) Category 3—dwellings distance less than 30 m from heavily travelled roads, or rail lines or subject to frequent aircraft flyovers.

(7) 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.

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

(6) Daytime adjustment means an adjustment of 10 dBA above the nighttime basic sound level with daytime being the period between 7 a.m. and 10 p.m.

(7) Class A adjustments are described and set out in Table 2.

Table 2. Class A adjustments*

Class	Reason for adjustment	Value (dBA L_{eq})
A1	Seasonal adjustment for wintertime conditions must not be added when determining the permissible sound level for design purposes. In the case of winter time noise complaint under Section 5 of this rule, this adjustment may be used in determining the permissible sound level.	+ 5
A2	Ambient adjustment is applicable if the measured ambient sound level is not representative of the assumed ambient sound environment. The ambient sound levels may be measured in areas considered to be pristine as defined in Appendix 1 or areas that have non-energy industrial activity that would increase the ambient sound levels. In the case where there are existing energy-related facilities located within an area and the assumed ambient sound level without the existing energy facilities as determined from Table 1 is considered not representative of the actual sound levels, the area may be eligible for an ambient adjustment. An ambient adjustment for one dwelling may be applied to other dwellings within the same project study area that have a similar acoustic environment. To be deemed similar, justification must be provided demonstrating that the difference in daytime or nighttime ambient sound levels at the dwellings is no greater than 3 dBA different from the assumed ambient sound level. Use Figure 1 to determine the applicable adjustment value.	-10 to +10

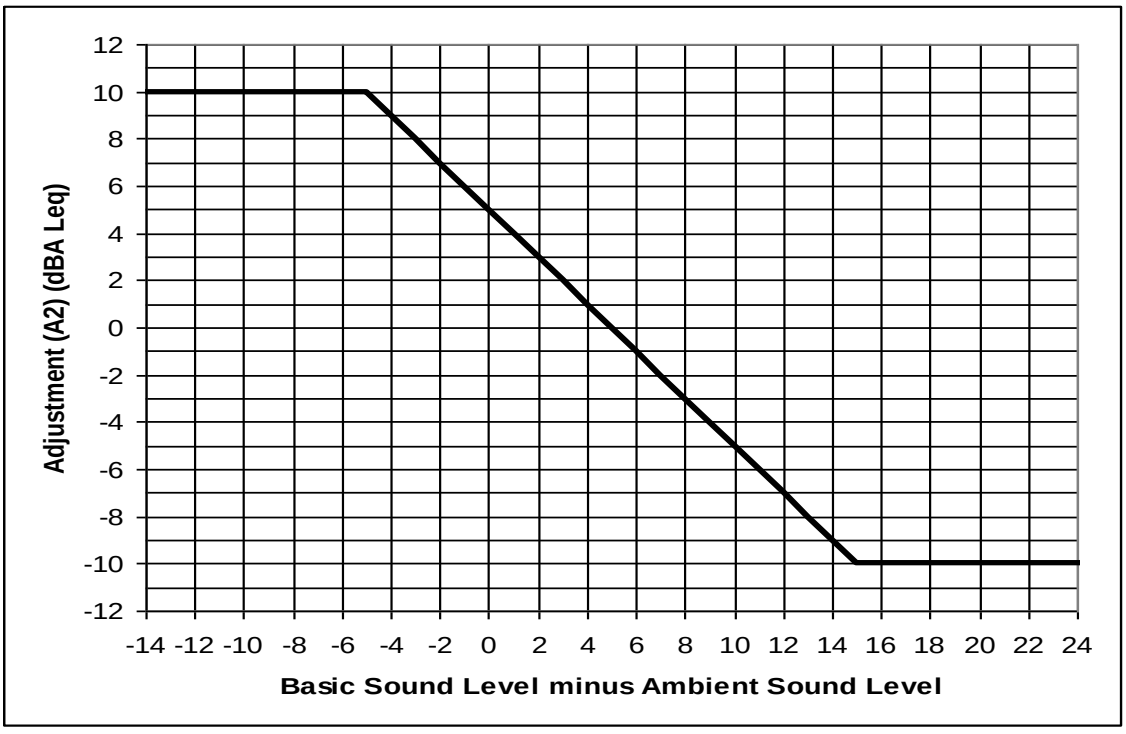
*Class A adjustment = Sum of A1 and A2 (as applicable), is not to exceed of +/- 10 dBA L_{eq}.

(8) Class A2 Adjustment

- A Class A2 adjustment is an adjustment to the permissible sound level for locations where the measured ambient sound level is different from the assumed ambient sound level referred from Table 1.
- A Class A2 adjustment is based on the measured ambient sound level in an area measured in accordance with the ambient sound monitoring survey in Section 4 of this rule.
- After completing the ambient sound survey, an applicant must use Figure 1 for an A2 adjustment and
    1. determine the difference between the basic sound level (Table 1) for the applicable dwelling density, transportation proximity and the measured nighttime and daytime ambient sound level 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 the applicable A2 adjustment value; it may be positive or negative, and
    5. add this adjustment value to any other applicable Class A adjustment value to arrive at the Class A2 adjustment. If the sign of A2 is negative, add a negative number to arrive at the Class A adjustment.

- If a Class A2 adjustment is requested, the noise impact assessment must indicate the permissible sound level results with a Class A2 adjustment and without a Class A2 adjustment.
- An applicant seeking a Class A2 adjustment under Section 2 of this rule must:
    - conduct an ambient sound level survey,
    - include in its public consultation program for the proposed facility information relating to the A2 adjustment request for each location,
    - define the area eligible for an A2 adjustment and identify the energy-related facilities located within the area,
    - identify whether an area is an urban or country residential location wherein an adjustment applicable for one dwelling may be applied to other dwellings within the area because the dwellings have a similar acoustic environment**,**
    - explain if the acoustic environment is influenced by factors such as non-energy related industrial activity, proximity to transportation infrastructures or population density,
    - identify the multiple acoustic environment areas if requesting multiple adjustments for one proposed facility,
    - provide justification on the applicability of the same Class A2 adjustment to other dwellings in the area, if a Class A2 adjustment is requested for an area with more than one dwelling in an urban setting, but noise measurements were taken at only one location.

Figure 1 - Ambient monitoring adjustment, Class A2 adjustment



(9) Class B adjustments are values set out in Table 3 to permit an adjustment to the basic sound level for temporary noise generating activities. Temporary noise generating activities are those lasting up to 60 days and not expected to occur more than once every 12 months. In order to use this adjustment, the licensee must 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

(10) A licensee must keep technical information to support the licensee's use of any of the adjustments to the basic sound level.

2.2 Permissible sound level 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 with the permissible sound level established under Section 2.1 of this rule, in the absence of a noise complaint.

(2) If a noise complaint is filed with the Commission against a deferred facility where a permissible sound level has not been previously established, the licensee must establish the permissible sound level in accordance with Section 2.1 of this rule.

(3) In the absence of a noise complaint in respect of a deferred facility, where the licensee applies to modify the facility, the permissible sound level will be the measured sound level as determined from a prior or new comprehensive sound level survey. However, a licensee must reduce noise from a deferred facility to accommodate the introduction of new noise sources at the facility so that there is no net increase in total noise at the most impacted dwelling(s).

(4) 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 of a deferred facility must demonstrate compliance with the permissible sound level as determined in Section 2.1 of this rule.

2.3 Permissible sound level for a proposed dwelling in proximity to a facility

(1) Where a person builds a dwelling or receives a building permit within 1.5 km from the boundary of an existing or approved facility, the

permissible sound level at the new dwelling, will be the greater of the cumulative sound level existing at the time of construction of the new dwelling, or the permissible sound level as determined in this section.

(2) A licensee must keep documentation of communication between the licensee and a person proposing to build a dwelling within 1.5 km of the boundary of the facility property including a copy of the noise impact assessment or other data provided to that person.

(3) When a licensee is notified that a person is proposing to build a dwelling within 1.5 km of the boundary of the facility property, if requested by the person, the licensee must communicate information regarding existing noise levels to that person. Where a noise impact assessment for the facility exists, the licensee must provide it to that person. In the alternative, the licensee may provide the existing sound level survey or modeling data extrapolated to the person's proposed building site.

2.4 Permissible sound level determination for a proposed facility near a deferred facility

Where a facility is proposed to be constructed near a deferred facility, the permissible sound level is determined based on the deferred facility status and this permissible sound level may be used while the deferred facility is operating or until October 17, 2018 at the latest.

2.5 Noise management plans

(1) For unique cases, if the Commission considers that a comprehensive sound level survey is not practical, a detailed noise management plan approved by the Commission may be used to demonstrate compliance.

(2) A noise management plan 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.

(3) A licensee must discuss a proposed noise management plan with all affected persons, such as nearby residents, operators of energy-related facilities, other industries, and local government. When submitting a noise management plan, the licensee must describe the consultation process and indicate if any affected persons have outstanding concerns with the plan.

3 Noise impact assessments

3.1 General requirements

(1) Subject to subsections (4) and (5) below, an applicant must file a noise impact assessment in accordance with this rule for the proposed facility

and predict the potential noise impact of the proposed facility under normal facility operating conditions at the most impacted dwelling(s).

(2) When planning a facility in an area where there is an existing or proposed energy-related facility, the applicant must ensure that its facility will not cause the cumulative sound levels to exceed the permissible sound level.

(3) The most impacted dwelling(s) must be identified for each defined area of similar acoustic environment for inclusion in a noise impact assessment.

(4) In the cases referred to in subsection (3) above, if the predicted cumulative noise during normal operating conditions, including the assumed ambient sound level for the proposed facility or proposed modification to an existing facility, is within six dBA of the permissible sound level at the most impacted dwelling(s), a noise impact assessment must be submitted.

(5) If a noise impact assessment is not submitted, the applicant must demonstrate how noise levels are not affected by the proposed facility or modifications to a facility. An Appendix 3 - Noise impact assessment summary form may be submitted.

(6) Where the facility application or exemption pursuant to AUC Rule 007: *Rules Respecting Applications for Power Plants, Substations, Transmission Lines, and Industrial System Designations* (AUC Rule 007) relates to an electric transmission line or substation of 240/260 kilovolt (kV) or less, to a small power plant with a capacity of less than one megawatt (MW), or to a meter station on a gas utility pipeline installation, an Appendix 3 - Noise impact assessment summary form may be submitted to satisfy the requirements of AUC Rule 007.

(7) Construction noise

Licensees must manage the impact of construction noise on nearby dwellings. The following mitigating measures should be used:

- 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.
- Ensure that all internal combustion engines are well maintained with muffler systems.

Should a noise complaint be filed during construction, the licensee must respond expeditiously and take prompt action to address the complaint.

3.2 Noise impact assessment requirements

A noise impact assessment must include:

(1) Permissible sound level:

Determine the permissible sound level and the direction and distance to the most impacted dwelling(s). This includes all details showing how the permissible sound level was determined and any adjustments claimed, including supporting document for a Class A1, A2 or B adjustment.

(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 or pressure levels in octave bands.

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

(3) Operating conditions:

It may be necessary to modify the manufacturer's data to account for actual operating conditions. The noise impact assessment must indicate the design conditions, such as operating with open or closed facility building windows and doors or restricted modes of operation.

(4) Information requirements for the noise impact assessment report:

- geometric spreading,
- barrier effects,
- atmospheric absorption,
- source identification,
- source size, location and elevation,
- sound power level and/or sound pressure level spectral data,
- intermittency of noise,
- mild downwind and/or temperature inversion conditions,
- type of noise propagation model used (models or hand calculations may be used to obtain the predicted sound level),
- standards followed,
- source directivity considerations,
- ground conditions and ground attenuation factor,
- meteorological parameters such as wind speed and duration,
- terrain parameters,
- reflection parameters, and
- any adjustments made (documentation of power level calculation, assumptions made must be provided, e.g. source size considerations).

(5) Noise model input parameters:

The following input parameters used in modeling summertime conditions,

- wind speed of 5 to 7.5 kilometres per hour (km/h) (1.4 to 2.1 metres per second (m/s)),
- wind direction: from the facility to the dwelling(s),

- temperature: 0 to 25 degrees Celsius,
- relative humidity: 70 per cent to 90 per cent,
- topography consistent with site conditions,
- acoustical properties of ground region by accounting for ground factor (G). Three categories of factor G for ground conditions are described below:
    - hard ground (G=0), which included paving, water, ice, concrete, tamped ground, and all other ground surfaces having a low porosity,
    - porous ground (G=1), which includes ground cover by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land, and
    - mixed ground: if the surface consists of both hard and porous ground, then G takes on values ranging from 0 to 1, where the value being the fraction of the region that is porous.

(6) Outline of study area:

Include a figure, map, area plan or drawing showing the proposed facility property, study area and the 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. Also, if Class A2 adjustment is requested, indicate the dwelling(s) for which the adjustment is sought.

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

(8) Predicted sound level or compliance determination:

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

If there is a Class A2 adjustment, provide the results of the ambient sound monitoring survey.

Provide the predicted cumulative sound level with and without the Class A2 adjustment.

(9) Non-compliance determination and attenuation measures:

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

If the predicted sound level indicates non-compliance 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.

(10) Use models that meet accepted protocols and international standards (e.g., CONCAWE or ISO 9613).

(11) 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.

3.3 Noise impact assessment for wind turbines – additional requirements

(1) When selecting the locations of wind turbines, an applicant must limit cumulative noise levels at all dwellings to the permissible sound level determined in accordance with Section 2 of this rule.

(2) Wind turbine noise must be modeled using wind speeds at the turbine hub of six to nine m/s or 21 to 32 km/h to predict a worst-case condition.

(3) The model must include cumulative effects of adjacent wind turbines, adjacent energy-related facilities and proposed facilities within a three km radius of each affected dwelling. The predicted noise levels from wind turbines, existing energy-related facilities, proposed facilities and the ambient sound level must be compared to the permissible sound level.

3.4 Noise impact assessment records

A licensee must keep all supporting information relating to a noise impact assessment in the event that the Commission requests the information for reference if a noise complaint is filed, or a new dwelling is constructed in the proximity to the facility.

4 Noise measurement

4.1 General

(1) A facility is in compliance if the comprehensive sound level measured during representative conditions is equal to or lower than the established permissible sound level, taking into consideration any low frequency noise.

(2) For the purpose of determining compliance with this rule, noise is measured at a distance of 15 metres (m) from the most impacted dwelling(s) in the direction of the facility, rather than at the property line of the land on which the dwelling is located. Other measurement locations may be used if it is physically impracticable or acoustically illogical to measure where specified.

(3) A sound survey consists of minimum 24-hour duration. After isolation analysis, at least three cumulative hours of valid data in the nighttime sampling period (10 p.m. to 7 a.m.) and three cumulative hours in the

daytime sampling period (7 a.m. to 10 p.m.) under representative conditions must be obtained. An extended-duration survey of more than 24 hours may be required to ensure that representative conditions have been met.

(4) The measured sound level for a facility operating intermittently such as wind turbines or peaking units is based on noise generated for the duration of the operation and must not be an average of the entire nighttime or daytime periods if the facility does not operate for the entire period.

(5) Abnormal noise events not representative of the ambient environment must be isolated and removed from measurement data and the isolation analysis documented. Noise contribution from existing energy-related facilities must be isolated for ambient sound level surveys. Noise from energy-related facilities is not isolated for comprehensive sound level surveys.

4.2 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 dwelling(s) 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 most impacted dwelling must be determined in order to determine noise control options. This is most commonly done by assessing the sound power level of each noise source or a measured sound pressure level at a standard distance where each individual source is dominant.
- If the facilities are separated by some distance, the relative sound emission of each facility can be determined by taking measurements in the direction of the dwelling at points where noise from 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 due to vertical directionality of the sources, judgment must be used when assessing the sound levels (see Example 3 in Appendix 6).

(3) At points where two or more facility noise sources contribute to the total sound pressure level, the relative contributions must be explained in the report. For example, extensive near-field measurements can be conducted at the various noise sources and with the use of computer-aided modeling, predict the source contributions at the dwelling.

4.3 Isolation analysis

(1) Isolation analysis techniques are used to separate sound sources and obtain the sound level from the source of interest alone.

(2) During a comprehensive sound level survey, all sound sources are captured for the survey period. However, in a compliance monitoring survey, noise contributions from the licensee's facility are evaluated.

(3) Invalid or abnormal data can be extracted from the measured comprehensive sound level. Invalid data can include periods with unacceptable meteorological conditions or non-representative ground cover or facility operating conditions. Noise measured during temperature inversions or lapse conditions[1] is excluded unless the conditions are a frequent occurrence (the condition occurs more than 10 per cent of the time for a particular season) and can be measured at the dwelling. Such conditions affect the level 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 comprehensive sound level must be documented and supported by a digital or analog audio recording, operational log or event log.

(4) Criteria for removing data may include:

- maximum wind speed exceeded,
- measurement periods during precipitation,
- measurement periods where the monitor is upwind of the noise source (see Table 7),
- periods of noise dominated by biological activity such as birdcalls, frogs, typically at dawn or dusk,
- abnormal noise events, including aircraft flyovers and off-plant site vehicular traffic,
- other non-energy related sources of noise.

4.4 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 a multiple-night monitoring:

- conditions not representative of the complaint conditions,
- requirement for minimal hours of valid data not achieved,
- changing weather conditions,

[1] Temperature inversions or lapse conditions are defined as situations when temperatures in the atmosphere (usually measured at a height of 10 meters) are 1°C or more above the temperatures at ground level (usually measured at a height of two meters).

- changing atmospheric conditions,
- changing plant operating conditions,
- variable seasonal effects,
- significant noise contamination from distant noise sources,
- insufficient local meteorological data,
- 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 ending a multiple-night survey:

- Favourable weather conditions.
- Achievement of representative conditions, as described in the Noise complaint investigation form (in Appendix 4).
- Agreement from complainant that survey conditions were appropriate.
- Licensee acknowledgement that compliance is not achieved.

(4) Each nighttime result for multiple nights of 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 permissible sound level.

4.5 Low frequency noise

(1) 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 Hertz (Hz) or below:

- 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.
- There must be at least a five dB drop in level within two bandwidths on the opposite side of the frequency band exhibiting the high sound level.

(2) The presence of a pure tone, as defined above, is required in order to confirm that there is low frequency noise. 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 low frequency noise (see Appendix 5).

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

(4) A-weighting measurements typically discount the lower frequencies. Therefore, when low frequency noise is an issue, the dBA value may not

be satisfactory. Due to the complexity of determining low frequency noise, this is a specialized investigation. The procedure outlined below and in Appendix 5 is only completed in specific response to a low frequency noise complaint identified through the complaint investigation process.

(5) A low frequency noise condition may exist when both:

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

(6) When low frequency noise is an issue, measurements must be conducted in both C-weighted 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-weighted and A-weighted sound levels simultaneously.

(7) If a low frequency noise condition as defined above exists, five dBA must be added to the measured comprehensive sound level. If this value exceeds the permissible sound level, the licensee must identify the source of the low frequency noise and implement noise attenuation measure to address the issue in a timely way. Once low frequency noise control measures have been implemented, a follow-up comprehensive sound level and complaint investigation must be conducted to confirm that the low frequency noise condition has successfully been addressed.

(8) Wind generates high levels of low frequency sound that can mask the assessment of low frequency noise. Measurements of low frequency noise should only be taken when atmospheric conditions are favourable for accurate measurement (see Table 7 and Appendix 5).

4.6 Sound level surveys – ambient and comprehensive

The following information must be provided in the sound level survey report:

- an explanation of the noise monitoring procedures and weather measurement methodologies,
- a map and list of noise monitoring and weather measurement locations
- a list of noise monitoring and weather measurement equipment
- field calibration records,
- response setting for the sound level meter,
- the time, duration and number of monitoring periods,
- averaging period or interval for both noise and weather measurements,
- weather and ground conditions: temperature, wind speed, wind direction, humidity, precipitation, topography and ground cover at the monitoring location,
- graphs showing measured sound level during the measurement period,

- tabulated record of the time, duration, and description of extraneous noise events, and the methodology used to isolate and remove the energy-related facilities noise contribution,
- the dwelling(s) for which a Class A2 adjustment is being applied for,
- acoustical practitioner's information.
- distance and direction of dwelling(s) from the facility (include a map),
- list of equipment and equipment calibration date,
- 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 permissible sound level for the most impacted dwelling(s), measured sound level, isolation analysis results, and valid hours of the survey,
- in cases where low frequency noise was identified as a potential problem, provide the analysis and results.

4.6.1 Comprehensive sound level survey requirements for wind turbines

(1) When ordered to do so by the Commission in a condition of the approval; or in response to a noise complaint, a licensee of a wind farm must conduct post-construction noise monitoring.

(2) When determining the comprehensive sound level for monitoring related to a condition in an approval for a wind farm, the following constitutes representative conditions:

- The monitoring location must be at the dwelling(s) specified in the condition.
- In the case of non-compliance, if the signal-to noise ratio is weak, measurement at a reduced distance between the noise source and the dwelling may be used.
- Operation of wind turbines at a maximum noise emission output.
- Downwind condition (accurate within ± 15 degrees) between the dwelling and the wind turbine with predominant noise contribution at the dwelling(s).
- Wind speeds at the turbine hub of six to nine m/s.
- The wind induced noise at the microphone wind screen must not exceed 30 dBA or 10 dB below the permissible sound level whichever value is higher.
- Summer daytime and nighttime period.

4.6.2 Noise measurement specifications for wind farm monitoring

(1) The specifications for conducting comprehensive sound level surveys for wind turbines are provided in Table 4:

Table 4. Noise measurement specifications for wind farm monitoring

#	Description	Specifications
1	Sound level meter requirement	• Type 1 or type 2
2	Measurement intervals	• 1 to 10 minutes
3	Measurement parameters	• Leq
4	Frequency weighting	• A-weighted and C-weighted
5	Time weighting	• Fast
6	Frequency content	• Full octave and 1/3 octave band for tonality analysis
7	Audio recording	• For identification of abnormal noise event during unattended noise monitoring period
8	Microphone placement	• At least 15 m from a facade or other reflecting surface
9	Microphone height	• 1.5 m above ground • If applicable, 4.5 m above ground in complaint situation (i.e. nighttime complaint with second storey bedroom
10	Primary wind screen	• as per IEC 61400-11 • the wind induced noise test data for the manufacturer should be available when requested
11	Secondary wind screen (optional)	• as per IEC 61400-11, may be used to obtain an adequate signal-to-noise ratio at low frequencies at high winds • the influence on the frequency response must be documented and corrected • the wind induced noise test data for the manufacturer should be available when requested
12	Minimum monitoring duration	• 24 hour duration with a minimum of three cumulative hours of valid data in daytime and three cumulative hours in the nighttime period after isolation analysis

(2) Information requirements of wind turbines monitoring are listed in Table 5.

Table 5. Information requirements

#	Information Requirements
1	Description of sound level meter including other associated equipment
2	Location of the sound level meter including microphone height
3	Description of the anemometry equipment
4	Location of the anemometry equipment including height of wind speed measurement
5	Field equipment calibration records
6	Response setting for sound level meter
7	Number of noise measurement data points used in the determination of daytime or nighttime comprehensive sound level
8	Graphs showing measured sound levels and any isolated portion of the measurement data
9	Tabulated record of the time, duration, and description of abnormal noise events isolated from the ambient sound levels;
10	Make and model of wind turbine
11	Number of operational wind turbines during the measurement period
12	Power output of wind turbines during the measurement period
13	Date, time and duration of monitoring period
14	Averaging sample period for noise and wind measurements
15	Wind shear conditions at site, if any
16	Atmospheric conditions (wind speed and direction at the wind turbine location and the monitoring location, precipitation record)
17	Map showing all wind turbines, the noise monitoring location(s), all energy related facilities, dwellings and any heavily travelled roads, railroads or airports that affect ambient noise levels
18	Acoustical practitioner's information

4.7 Cumulative sound level

(1) The cumulative sound level includes the assumed or measured ambient sound level, any existing and approved but not yet constructed energy-related facilities, and the predicted sound level from the applicant's proposed facility, and when combined must not exceed the permissible sound level.

(2) The simplified method to predict sound level by reducing six dBA per doubling of distance is only acceptable for a small stationary single-source facility without the cumulative effect from any existing energy-related facility and with flat ground between the facility and the dwelling, or at 1.5 km distance (see example in Appendix 2 – Section 2.5).

(3) In cases where the simplified method is not acceptable, an applicant or licensee must use an acoustical practitioner to predict the cumulative sound level. When requested by the Commission, an applicant or licensee must provide all noise modeling documentation. Applicants or licensees must demonstrate the suitability of acoustical practices, equipment and techniques when measuring or modeling sound levels.

(4) In cases where no dwelling exists within 1.5 km of a facility property and the facility is adjacent to another energy-related facility such that the

1.5 km radius overlaps, in the overlapping portion the sound level may exceed the permissible sound level (see Example 3 in Appendix 6).

4.8 Measurement equipment

4.8.1 Sound level meters

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 61672-1 or ANSI publication S1.11-2004 (R2009) for Type II sound level meters.

4.8.2 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 field calibrated immediately prior to the measurement with a sound calibrator meeting the requirements of ANSI S1.40-2006 or latest revision,
- have their calibration checked immediately after the measurement using the same calibrator and a record of calibration results must be included in the report,
- 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 (e.g. 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 a pre-use or post-use field calibration test (e.g., the meter does read within plus or minus one dB) must not be used.

The sound level meter may be used for a two-year period dated from the Certificate of Conformance prior to requiring recalibration. The Certificate of Conformance must be kept on record, the same as a Certificate of Calibration. If the sound level meter does not come with a Certificate of Conformance as

described above, an initial Certificate of Calibration for the sound level meter is required prior to use.

4.8.3 Instrumentation setting for wind measurement

Table 6 defines the instrumentation setting for wind measurement.

Table 6. Wind measurement instrumentation and setting

#	Description	Specifications
1	Anemometer resolution	0.1 m/s (maximum)
2	Anemometer precision	+/- 0.2 m/s (maximum)
3	Anemometer location	In the direction of the nearest noise sources and within 100 m of the sound level meter with no obstruction in between the anemometer and sound level meter
4	Anemometer height	Same as the microphone of sound level meter
5	Sampling period	10 minutes (maximum)

4.8.4 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. The calibrator may be used for a one-year period dated from the Certificate of Conformance prior to requiring recalibration.

The Certificate of Conformance must be kept on record, the same as a Certificate of Calibration. If the calibrator does not come with a Certificate of Conformance as described above, an initial Certificate of Calibration for the calibrator is required prior to use.

4.9 Measurement conditions

4.9.1 Sound level

(1) In the noise impact assessment, if the facility was modeled to operate with doors and windows closed, then this is a condition of operation to ensure that the permissible sound level is met.

(2) Representative conditions do not constitute absolute worst-case conditions, or the exact conditions the complainant has identified if those conditions are not easily duplicated. In order to expedite complaint resolution, comprehensive sound level surveys should be conducted at the earliest opportunity when sound propagation towards the complainant's dwelling is likely and representative conditions might exist.

(3) If the permissible sound level was established for deferred facilities using modeling results, the outcome of the comprehensive sound level must be adjusted, if necessary, taking into account the input conditions used to generate the modeled results. For example, if the permissible sound level was determined by inputting calm summer conditions in the model, the comprehensive sound level must be measured under similar seasonal and meteorological conditions.

(4) When the measured comprehensive sound level exceeds the permissible sound level, but noise from the facility is not considered to be responsible for the exceedance, isolation analysis to further separate the facility noise contribution may be carried out (see Section 4.10.2).

(5) Invalid data (except in the case of wind turbine noise monitoring) may result if wind speeds are greater than those shown in Table 7. Wind gradients can greatly affect the sound levels measured. Table 7 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/h may be acceptable.

(6) The limits for wind speed (measured at a height between 1.2 m and 10 m 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 that the same conditions exist at the measurement position.

Table 7. Favourable summertime weather conditions

Parameter	Preferred condition
Ground cover	No snow, water, or ice (frozen) ground cover.
Precipitation	No steady precipitation.
Wind speed Measured at a height between 1.2 m and 10 m	Wind speed limits (noise data may be invalid if limits are exceeded): **Less than 500 m from noise source:** Downwind: 15 km/h limit **500 – 1,000 m from noise source:** Downwind: 10 km/h limit **Greater than 1,000 m from noise source:** Downwind: 10 km/h limit A 24-hour noise sampling period: unless exceptional circumstances are encountered, there must be at least three cumulative hours of valid data (after isolation analysis) in the nighttime sampling period (10 p.m. to 7 a.m.) and three cumulative 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.

4.9.2 Wind measurement

(1) Wind measurement during noise monitoring is to verify representative conditions:

- define the wind speed and direction in the vicinity of the sound level meter,
- identify wind induced noise contamination on the microphone,
- define wind speed and direction at the operating wind turbine hub height,

- determine if downwind conditions are being measured,
- identify wind shear conditions.

(2) Wind speed and direction information is required at two locations during the monitoring period. One location is at the wind turbine hub height and the other location is in the vicinity of the sound level meter at the monitoring location. This information must be documented.

4.9.3 Measurement techniques

References for sound measurement techniques are found in Appendix 7.

5 Noise complaint

5.1 General

(1) If a noise complaint is filed by a resident of a dwelling near the facility after the facility is in operation, the licensee must meet the permissible sound level as determined in accordance with Section 2. This section does not apply where the resident is the person who constructed a dwelling under the circumstances set out in Section 2.3.

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

(3) If a facility is found to be noncompliant, the licensee must provide both a detailed noise control mitigation plan and a timeline as to when compliance will be met.

(4) When the facility meets the requirements in this rule, the Commission ends its investigation.

(5) If conditions at the facility change, a new complaint may be filed.

(6) 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.

5.2 Investigation

(1) If monitoring is conducted due to a noise complaint, a completed Noise complaint investigation form (see Part 1 and Part 2, in Appendix 4) identifying the representative conditions for monitoring must be completed and submitted to the Commission.

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

(3) When investigating a noise complaint, licensees must first attempt to resolve the issue through direct contact (documented telephone calls or

meetings) with the complainant to understand the concerns and establish a dialogue.

5.3 Investigation form

(1) In Part 1 of the Noise complaint investigation form, the licensee must enter information from the complainant(s) about the character of the noise and the weather and ground cover conditions that exist when the noise is most annoying. These and the facility operating conditions (as described in Section 4) are the representative conditions of the noise complaint under which the comprehensive sound level survey should take place.

(2) Part 2 of the Noise complaint investigation form, the event log, is for use by the complainant(s) to record details about environmental and facility operating conditions under which noise adversely affects them. If the complainant does not complete Part 2 of the Noise complaint investigation form, the licensee must describe efforts to involve the complainant, use its judgment to approximate representative conditions, and explain how those conditions were determined.

(3) A licensee must provide a copy of the completed Noise complaint investigation form to the complainant and include a copy in the comprehensive sound level report to demonstrate that the representative conditions were met.

(4) The completed Noise complaint investigation form is used to determine conditions representative of the complaint. If this completed form is not available, Table 7 outlines the favourable summertime weather conditions for noise monitoring.

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.
Acoustical practitioner	An acoustical 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)	The sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The ambient sound level does not include noise from any energy-related facilities and must be determined without it. The ambient sound level can be measured when the sound level in an area is not believed to be represented by the basic sound levels in Table 1. The ambient sound level must be measured under representative conditions and does not constitute absolute worst-case conditions (e.g. an unusually quiet day) but conditions that portray typical conditions for the area. Also see Representative conditions. In the absence of measurement, the nighttime ambient sound level is assumed to be five dBA less than the basic sound level and the daytime ambient sound level is assumed to be five dBA less than the basic sound level plus the daytime adjustment.
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 below.

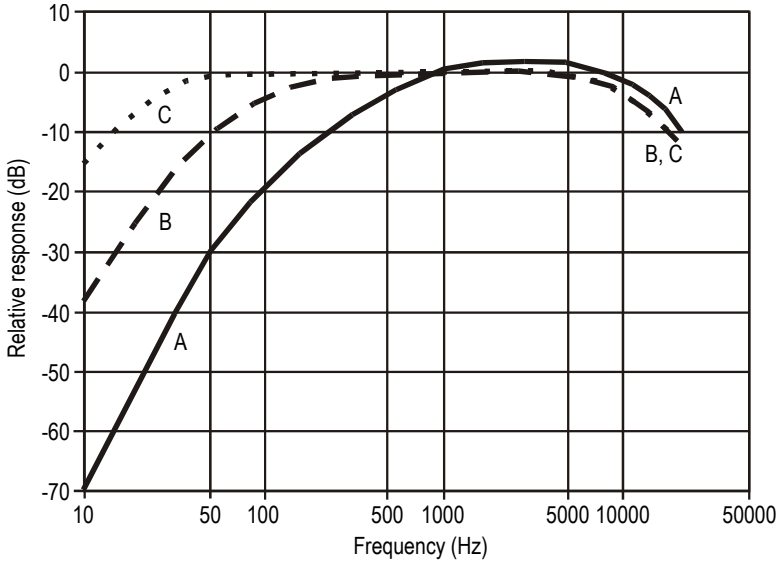


Figure 2 - Weighting network curves

Bands (octave, one-third octave)	A series of electronic filters separate sound into discrete frequency bands, making it possible to know how sound energy is distributed as a function of frequency. Each octave band has a centre frequency that is double the centre frequency of the octave band preceding it. The one-third octave band analysis provides a finer breakdown of sound distribution as a function of frequency.
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 and is assumed to be five dBA above the ambient sound level 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 basic sound level, using Table 1 in this rule.
Category 1	Dwellings distance is more than equal to 500 m from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers. Also see Category.
Category 2a	Dwellings distance is more than or equal to 160 m but less than 500 m from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers. Also see Category.

Category 2b	Dwellings distance is more than or equal to 30 m but less than 160 m from heavily travelled roads or rail lines and not subject to frequent aircraft flyovers. Also see Category.
Category 3	Dwellings distance is less than 30 m from heavily travelled roads or rail lines 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 (A1 cannot be used for design purposes) and the actual ambient sound level in an area (A2). The Class A adjustment is added to the basic sound level to arrive at the permissible sound level and cannot exceed +/- 10 dBA.
Class B adjustment	An adjustment applied for temporary noise generating activities which are activities lasting 60 or fewer days and not expected to occur 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.
Comprehensive sound level (CSL)	The comprehensive sound level includes ambient sound level, noise from existing energy-related facilities and should exclude abnormal noise events. Also see Representative conditions.
Cumulative noise level	The cumulative noise level includes the comprehensive sound level, noise from energy-related facilities approved but not yet constructed, and the predicted noise from the applicant's proposed facility.
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 (e.g., 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. $$Sound\ pressure\ level\ (dB) = 10 \log\left(\frac{p^2}{p_o^2}\right)$$ $$= 20 \log\left(\frac{p}{p_o}\right)$$ 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 that approximates human hearing response at low intensities. Also see dB and A-weighted sound level.
Deferred facility	Energy-related facilities constructed and in operation prior to October 1988. These facilities do not have to demonstrate compliance with this rule 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	Any permanently or seasonally occupied structure used for habitation for the purpose of human rest; 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. A permanent dwelling is a fixed residence occupied on a full-time basis. A seasonally occupied dwelling is 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 dwelling 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 manufactured homes are examples of seasonally-occupied dwellings, while a holiday trailer simply pulled onto a site is not.

The most impacted dwelling(s) are those subject to the highest average weighted sound level relative to the permissible sound level.

The nearest dwelling may not necessarily be the one most impacted by noise 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 and experience louder noise.

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})

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 hours) 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.

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

See Appendix 2 for more detail on the L_{eq} concept.

Energy-related facility

A facility under the jurisdiction of the Commission or other regulatory agency, used for energy generation, transport (except by road or rail line) and resource extraction. These include mining, extraction, processing and transportation (except by road or rail line) as well as federally regulated electrical transmission lines and pipelines.

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 (e.g., 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.

Far field	The far field is that area far enough away from the noise source that the noise emissions can be treated as if they come from a single point or line source and the individual components of the noise source are not apparent as separate sources. This is typically at a distance of at least three to five times the major dimensions of the noise source.
Filter	A device separating the components of an incoming noise by its frequencies.
Frequent aircraft flyovers	A location that has a minimum of nine aircraft takeoffs or landings over the nighttime period. A dwelling must be within five km of the airport to qualify for the BSL adjustment in the assessment of categories as part of a site-specific analysis for dwellings that lie within a noise exposure forecast contour area with a noise exposure forecast 25 or greater, as designated by Transport Canada. In the absence of any noise exposure forecast contours for a local airport, Transport Canada can be contacted for current air traffic statistics. 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 consistently for any one month period in a year. The following methods to validate the travel volume are acceptable: • Traffic count by attended technician for the entire nighttime period with the dates documented • Traffic count by audio recording during the sound monitoring period with the dates documented • Hourly traffic volume data from Alberta Transportation or other municipalities • Alberta Transportation's Average Annual Summer Daily Traffic (ASDT) value • If the ASDT is not available, the Alberta Transportation's Average Annual Daily Traffic (AADT) value can be used In the case of using the ASDT or AADT, 10 per cent of the daily traffic volume can be assumed to be the nighttime period traffic
Isolation analysis techniques	Various sound measurements and analytical techniques used to separate various sound sources and to determine 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 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	Where a clear tone is present below and including 250 Hz and the difference between the overall C-weighted sound level and the overall A-weighted sound level exceeds 20 dB.
Near field	The region close to the source where the inverse-square law (six dBA loss per doubling of distance for a point source) does not apply. Usually this region is typically closer than three to five times the major dimensions of the noise source.
Nighttime	Defined as the hours from 10 p.m. to 7 a.m.
No net increase	The logarithmic addition of sound pressure levels when predicting noise where the sum does not exceed the permissible sound level by 0.4 dBA.
Noise	The unwanted portion of sound.
Noise exposure forecast	The noise exposure forecast contours are site specific to each airport and take into account such factors as traffic levels, proximity to runways, flight paths, and aircraft type and size.
Noise impact assessment (NIA)	A noise impact assessment predicts the expected sound level emanating from a facility as measured 15 m from the most impacted dwelling(s). It also identifies what the permissible sound level is and how it was calculated.
Permissible sound level (PSL)	The maximum daytime or nighttime sound level as determined in Table 1 at a point 15 m from the dwelling(s) in the direction of the facility. The permissible sound level is the sum of the basic sound level, daytime adjustment, Class A adjustments and Class B adjustment.
Pristine area	A natural area that might have a dwelling but no industrial presence, including energy, agricultural, forestry, manufacturing, recreational, or other industries that affect the noise environment.
Proposed facility	A proposed facility is a facility for which an application has been deemed complete by the Commission, 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 train passage during every nighttime period consisting of 25 cars.
Representative conditions	For ambient sound levels, these are conditions that portray the typical activities for the area, not an unusually quiet time (non-frequent occurrence – less than 10 per cent of the time for a particular season). For comprehensive sound levels, 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.
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.
Sound level meter	An instrument designed and calibrated to respond to sound and to give objective, reproducible measurements of sound pressure level. Its frequency response and averaging times may be adjusted 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	The decibel equivalent of the rate of energy (or power) emitted in the form of noise. The sound power level is given by: $Sound\ Power\ Level = 10 \log \left(\frac{sound\ as\ power\ (watts)}{W_o} \right)$ By international agreement, $W_O = 10^{-12}$ watts (W) The sound power level is an inherent property of a noise source.
Sound pressure level	The decibel equivalent of the pressure of sound waves at a specific location, which is measured with a microphone. Since 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 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	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.
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 typically below 0°C.

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 has a higher sound pressure level on the linear scale (dB) than a high frequency sound and is perceived to be equally loud to the ear. These two sounds 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 hours) 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.

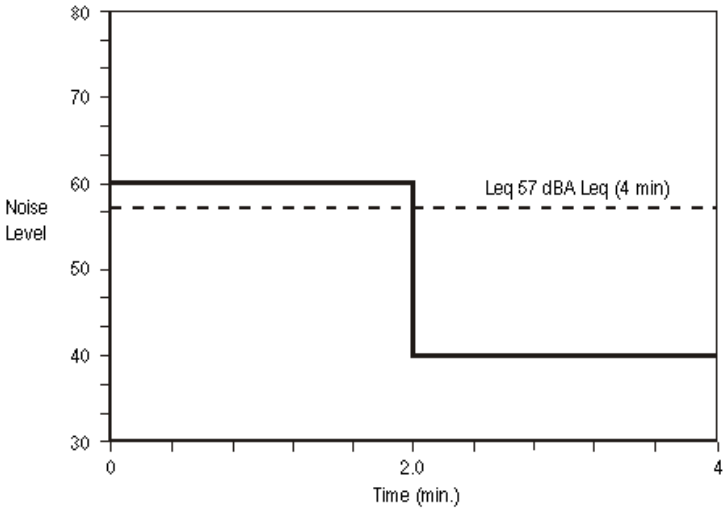


Figure 3 - Illustration of L_{eq} concept

In Figure 3, the equivalent energy during the four-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:

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

$$= 10\log\left(\sum_{1}^{240} f_i \times 10^{L_i/10}\right)$$

$$= 10\log\left(\frac{120}{240}\times 10^{60/10} + \frac{120}{240}\times 10^{40/10}\right)$$

$$= 10\log\ (505\,000)$$

$$= 57\ dBA\ L_{eq}\ (4min)$$

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 one hour. For 59 minutes, the sound level is 40 dBA (fairly quiet), and for one minute it is 90 dBA while a train passes:

$$L_{eq} = 10\log\ (f_1 \times 10^{L_1/10} + f_2 \times 10^{L_2/10})$$

$$= 10\log\left(\frac{59}{60}\times 10^{40/10} + \frac{1}{60}\times 10^{90/10}\right)$$

$$= 10\log\ (0.98\times 10^4 + 0.02\times 10^9)$$

$$= 73\ dBA\ L_{eq}\ (1\ hr)$$

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:

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

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 8 gives examples of values of Q for a variety of location geometries.

Table 8. 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 of the Appendix 2, L_{eq} concept, can be used to add sound levels together both for the A-weighted levels and by the different frequency bands. This formula is useful for adding together sound power or sound pressure levels from different components of a facility, for example, to arrive at a composite sound level for the facility.

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:

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

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

Example calculation of addition of sound power levels

A facility will be constructed and the manufacturer stated 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 (non-directional) 113 dBA

Piping noise 79 dBA

$$L_{power,total} = 10\log\left(10^{L_1/10} + 10^{L_2/10} + \cdots + 10^{L_n/10}\right)$$

$= 10 \times \log_{10} \left(10^{106/10} + 10^{113/10} + 10^{79/10} \right)$
$= 10 \times \log_{10} \left(10^{10.6} + 10^{11.3} + 10^{7.9} \right)$
$= 10 \times \log_{10} \left(2.394 \times 10^{11} \right)$
$= 10 \times 11.38$
$= 113.8$ dBA (ref 1 pW)

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 R_1=50 metres can be used as a rule of thumb.

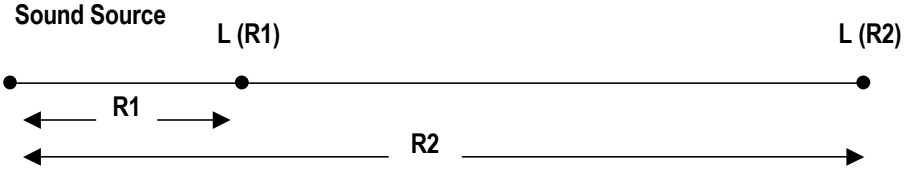
(3) The inverse square law (six-dB loss per doubling of distance) for sound dissipation over distance does not apply for near-field measurements. The near field is the area where the dimensions of the source are significant; it applies to sound pressure levels measured at distances less than about five times the size of the source object. The data supplied by manufacturers is often provided as sound pressure levels measured very close to the equipment (e.g., in the near field) and is 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 – 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 the second term in the equation is negative if R_2 is less than R_1, 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 the sound level at a different distance

The sound level measured at 50 m from the source is 75 dBA. A dwelling is located 800 m away from the facility. What is the sound level calculated at the dwelling?

Measured L (50 m) = 75 dBA.

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

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

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

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

$$L(800\ m) = 51\ dBA$$

So the sound level contribution due to the facility is 51 dBA at 800 m.

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

A simplified way to estimate the sound level is to use the rule of six dB lost per doubling of distance. With this method, subtract six dB each time the distance from the noise source is doubled.

If the measured sound level is 75 dBA at 50 m from the source:

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

This method results in 51 dBA at 800 m. This result matches the calculation above. The simple table method only estimates sound values at discrete distance points. If sound values between the distance points are required, use the formula 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 Appendix 2 - 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

(Please retain detailed records for audit purposes)

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 most impacted dwelling(s) or at a distance of 1.5 km where there are no dwellings:

Dwelling Distance from facility (m)	Dwelling 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).

New and/or Existing Equipment Noise Sources (include make and model, power rating)	Predicted or Measured ☐ PWL (dBA) or ☐ SPL (dBA)	☐ PWL (dBA) or ☐ SPL (dBA)	Data source (Vendor Measurement theoretical, etc.)	Distance SPL measured from the noise source (m)

Provide a tentative schedule and timing for the operation, maintenance and testing of the equipment

_____

_____

_____

3. Normal 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, load, RPM). Describe any considerations and assumptions used in conducting estimates:

_____

_____

4. Noise modeling parameters

If modeling was conducted, identify the model input parameters used (see Section 3.5):

_____

(continued)

5. Predicted sound level/compliance determination

Identify the predicted sound level at the most impacted dwelling or at a distance of 1.5 km where there are no dwellings. 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 contribution from the new or modified facility alone at the most impacted dwelling or at a distance of 1.5 km where there are no dwellings.

Nighttime sound level: _____ dBA L_{eq} Daytime sound level: _____ dBA L_{eq}

Assumed ambient nighttime sound level: _____dBA L_{eq} Assumed ambient daytime sound level:__ dBA L_{eq}

Predicted sound level at the most impacted dwelling or at a distance of 1.5 km where there are no dwellings, from the new or modified facility including the cumulative effects of noise from energy-related facilities and the assumed ambient level (ASL + new facility + existing energy-related facilities).

Nighttime sound level: _____ dBA L_{eq} Nighttime permissible sound level: _____ dBA L_{eq}

Daytime sound level: _____ dBA L_{eq} Daytime permissible sound level: _____ dBA L_{eq}

Is the predicted sound level less than the permissible sound level by a margin of three dBA? Yes _____ No_____
If **No**, conduct a detailed NIA as per Section 3 of AUC Rule 012

6. Supply any other relevant information you want to provide to the AUC. Submit additional pages if required.

_____

_____

_____

7. If the permissible sound level is higher than 40 dBA Leq, provide supplementary information to support the use of such permissible sound level.

_____

_____

_____

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

_____

_____

_____

9. Acoustical practitioner's information (See Section 3.9 (9)):

Company:
_____

Name:
_____

Experience:_____

Title: _____Telephone:_____ Date: _____

Appendix 4 – Noise complaint investigation form

PART 1 (To be completed by licensee)

Date (DD/MM/YYYY):_____

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)

Event log
PART 2 (To be completed by complainant)

Resident: _____ Licensee contact: _____

Telephone: _____ Telephone: _____

List any details related to the sound from the facility that is annoying you. Refer to the descriptions at the bottom for assistance in providing information**.**

Date (DD/MM/YYYY)	Time a.m./p.m.	Noise characteristics	Weather conditions	Ground cover	Receiver location

Noise characteristics: Describe the sound as a high or low tone, steady or pulsing.

Weather conditions: To the extent possible, provide details on temperature, wind direction and speed, cloud conditions (clear or cloudy), and existence of precipitation when the sound is a problem.

Ground cover: Describe what is covering the ground around the facility; for example, is it snow, water, grass, crop, trees, ice..etc.

Receiver location: Note where you were when the sound was annoying (outdoors, such as on the deck or in the yard or corrals, or indoors, such as in the bedroom or living room).

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 permissible sound levels are typically higher in the daytime than during the night, the methods described focus on the nighttime periods. However, the low frequency noise 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 low frequency noise, the acoustical practitioner 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 low frequency noise

If there is a low frequency noise 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 4.4. 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 interval 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 low frequency noise

If the suspected low frequency noise 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 low frequency noise. 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 low frequency noise may be a consideration, measurements of the local wind conditions must be taken throughout the assessment period at a height of 1.2 m to 10 m above ground in the vicinity of the sound monitoring location(s) based on the professional judgment of the acoustical practitioner. Wind generates high levels of low-

frequency (and infrasonic) sound energy, which can mask or confuse the assessment of facility low frequency noise.

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).

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

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.

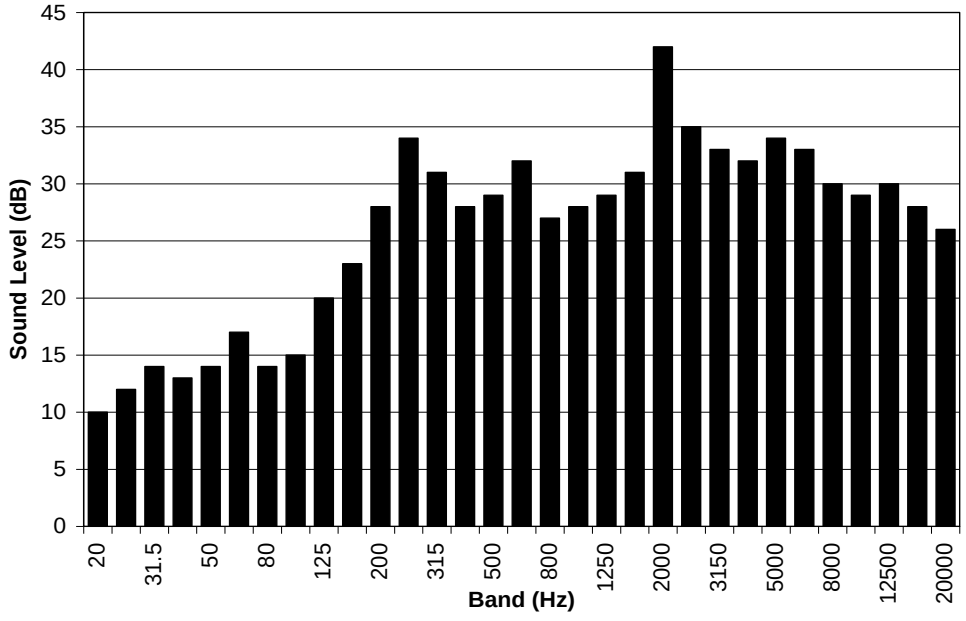


Figure 5 - One-third octave ban centre frequency (Hz)

Appendix 6 – Examples

The examples below show a step-by-step process to determine compliance or non-compliance for new or existing facilities that: may request an A2 adjustment (Example 1); use the simplified calculation described in Appendix 2 - Section 2.5 (Example 2); or may require consideration of cumulative effects (Example 3).

Example 1

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

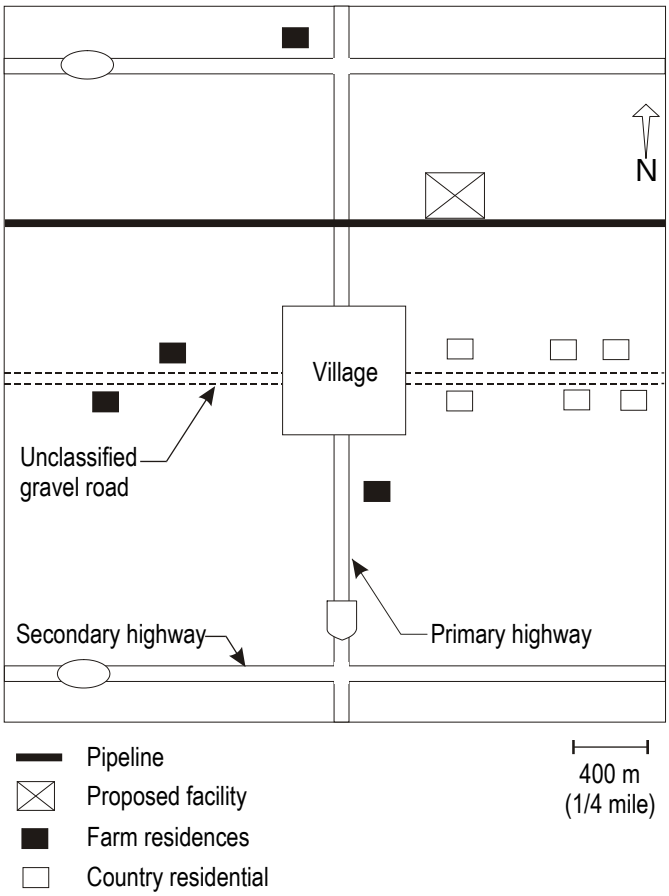


Figure 6 - Area sketch for example 1

Example 1 - Solution

Step 1 Determine BSL.

All three possible dwelling densities are represented in this study area. The four 8.1 hectares (20 acre) country residential dwellings factored over a quarter section fall into the 1-8 dwellings density, as do the farmhouses. The two country residential dwellings closest to the village and a portion of the village are in the 9-160 dwellings density, while the body of the village is in the >160 (greater than) dwellings density.

Regarding the proximity to transportation Category: the primary and secondary highways in this example are heavily travelled which causes the adjacent farmhouses to fall into Category 2, while the dwellings in the village would fall into Category 2 or 3, based on population density and depending on the distance from the highway. The two country dwellings in closest proximity to the village fall into Category 2, while other four country dwellings that are east of the village further along the gravel road (which in this example is not a heavily travelled road), fall into Category 1 The farmhouses along the gravel road fall into Category 1.

It appears that the Category 1 country dwellings to the south of the proposed facility are probably the nearest and most impacted, with a nighttime BSL of 40 dBA L_{eq}, from Table 1-Basic Sound Levels for nighttime. However each dwelling is assigned its own site specific BSL. Where there is more than one category and dwelling density in a study area it may be difficult to ascertain the most impacted dwelling as it may not be the nearest dwelling to the proposed facility. The difference between the determined permissible sound level and predicted sound level will assist in the determination of the most impacted dwelling.

Step 2 What is the daytime sound level adjustment?
The daytime sound level adjustment is 10 dBA above the BSL. (For a continuous facility noise source where there is no difference in operational noise level between the daytime and nighttime period, the facility sound level must be designed to comply with the most stringent criteria which is usually the lower nighttime permissible sound level.)

Step 3 Is a Class A1 Seasonal Adjustment appropriate?
No, because this adjustment cannot be added when determining the permissible sound level for design purposes.

Step 4 Is the BSL appropriate for this area or is the use of a Class A2 Ambient monitoring adjustment warranted?
In this example assume no, because of presence of a non-energy related noise source in area (feedlot that operates 24-hours). The licensee of the proposed facility has taken some spot measurements with a hand-held sound meter. The levels recorded ranged from 42 dBA at night to 55 dBA during the day. Approval for using the A2 Ambient monitoring adjustment is required by the Commission prior to submitting the noise impact assessment.

Step 5 Assuming Commission approval of the use of the Class A2 ambient monitoring adjustment is received, a 24-hour ambient sound monitoring study measured at 15 m from the nearest country dwelling is conducted. The results of the survey are:

Daytime ASL: 53 dBA L_{eq}
Nighttime ASL: 37 dBA L_{eq}

Claim the appropriate daytime and nighttime A2 monitoring adjustment for the applicable dwelling (in this example the country dwelling nearest the facility and the feedlot) specific dwelling from Figure 1 - Ambient monitoring adjustment. First, subtract the appropriate daytime and nighttime ASL measured during the monitoring study from the BSL determined in step 2. In this example:

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 A2 adjustment that will apply to the daytime and nighttime periods. The A2 adjustment that apply in this example are:

Daytime adjustment: A2 = +8 dBA L_{eq}
Nighttime adjustment: A2 = +2 dBA L_{eq}

Step 6 Sum of the Class A adjustments: (A1 + A2 (call it A))
Daytime: 0 + 8 = 8 dBA L_{eq}
Nighttime: 0 + 2 = 2 dBA L_{eq}

Step 7 Is the Class A adjustment greater than 10 dBA L_{eq} (only a maximum of 10 is allowed)?
In either case, no.
Class A ambient adjustment = 8 dBA daytime
Class A ambient adjustment = 2 dBA nighttime

Step 8 Is noise temporary in nature?
In this example assume no; the facility will operate all year (more than 60 days).
Class B adjustment: B = 0 dBA

Step 9

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 m from the nearest country dwelling.

Example 2 – Noise impact assessment (simple calculation)

A new facility is proposed for the area shown in Figure 7. The most impact dwelling is along a road not heavily travelled; therefore it is a Category 1 proximity to transportation. The density of dwelling is in the 1-8 range. From Table 1, the BSL at nighttime is 40 dBA and since no additional adjustments are required, the PSL is 40 dBA L_{eq} nighttime. The sources of noise from the facility are the cooler fans and exhaust noise. The manufacturer has stated that the maximum sound level emitted from this equipment is 55 dBA measured at 50 m in front of the cooler fans.

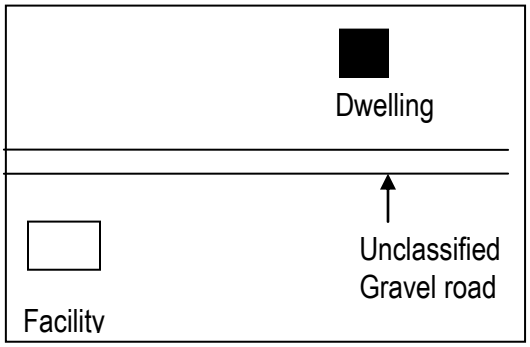


Figure 7 - Area sketch for example 2

Example 2 - Solution

The table below demonstrates the use of the doubling of distance method to estimate the sound level from the source:

Distance (m)	Sound Level (dBA)
50	55
100	49
200	43
400	37
800	31

Note that this is a small, stationary, single source facility without any existing energy-related facility in the proximity and with flat ground between the facility and a single dwelling.

The six dBA loss per doubling of distance is a rough estimate. A more accurate way to determine the sound attenuation with distance is to measure similar equipment at a topographically similar location. The sound levels would be measured at specified distances away from the facility (for example, 100 m, 200 m, 400 m, etc.) to determine the actual attenuation with distance.

The nighttime PSL must be met. Many permanent facilities create the same amount of noise whether it is daytime or nighttime, and so the most stringent criterion is the nighttime PSL.

The noise impact assessment developed for this example would include the following:

1) The major sources of noise in this facility include cooler fans and exhaust noise.
2) The sound levels at the nearest dwelling have been predicted using the six dBA loss per doubling of distance calculation method. Sound level losses for air absorption, ground attenuation, or cooler fan orientation away from the dwelling have not been included. The only noise source input is the 55 dBA at 50 m.
3) The distance to the most impacted dwelling is 800 m to the northwest. This also happens to be the closest dwelling. If we extrapolate the 55 dBA value out to 800 m, using the theoretical six dBA loss per doubling of distance:

   L is sound level at distance R

   $L(R2) = L(R1) – 20 \log (R2/R1)$

   $L(800) = 55 – 20 \log (800/50)$

   $L(800) = 30.9$

   The predicted sound level at the dwelling from the facility alone is 30.9 dBA. Adding this to the assumed rural ambient sound level (35 dBA L_{eq}) results in a combined predicted sound level of 36.3 dBA L_{eq}. With this result, the Appendix 3 Noise impact assessment summary Form can be submitted in the application as a substitute for the noise impact assessment.
4) 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

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

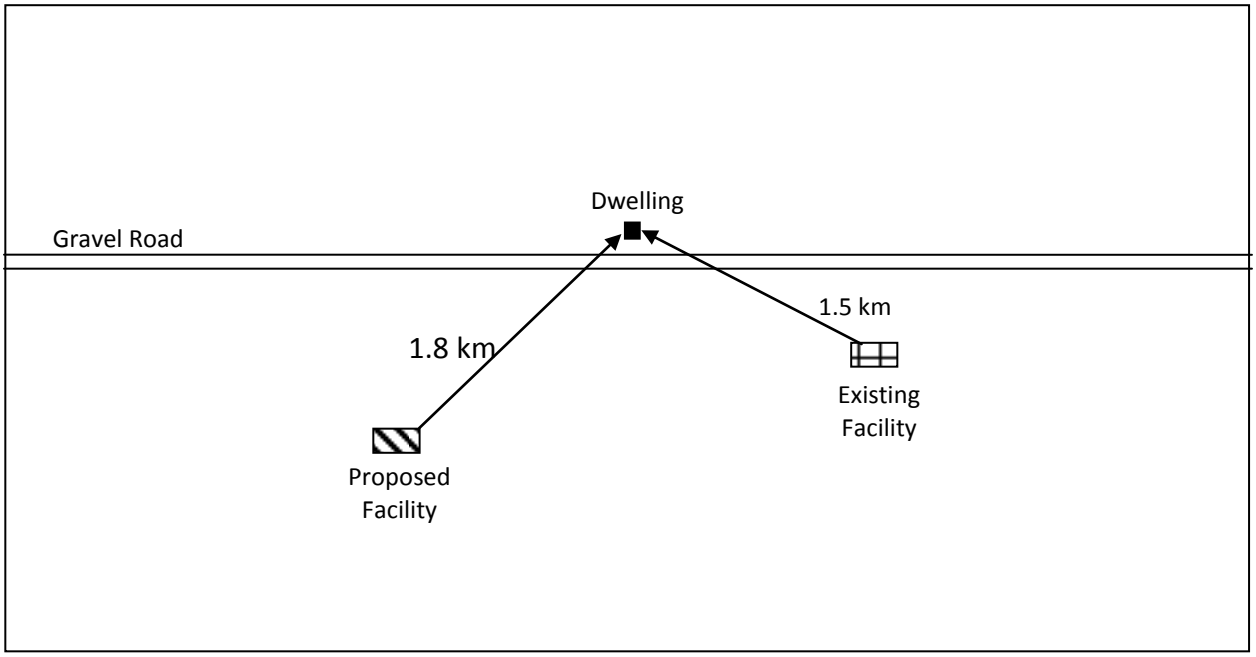


Figure 8 - Area sketch for example 3

Example 3 – Solution

The new facility is planned for an area where another regulated facility is present. AUC Rule 012 requires that cumulative effects be considered for potentially affected dwellings or at 1.5 km from the facility property. The acoustical practitioner must determine whether dwellings are present inside the 1.5 km distance or if there is potential for cumulative effects to occur at dwellings beyond the 1.5 km boundary. Two scenarios are examined: a proposed facility that does not contribute to noise levels at 1.5 km and a proposed facility that does contribute to noise at 1.5 km.

Solution A

The first method to demonstrate compliance of the proposed facility is to show "no net increase" in the existing sound level at the 1.5 km boundary.

1) The PSL based on Section 2.1 of the AUC Rule 012 is 40 dBA nighttime at 1.5 km. The corresponding ASL from Section 2.1 is 35 dBA.

2) Where there is no noise data available for the existing facility, the facility is assumed to be compliant so that it meets 40 dBA L_{eq} at its own 1.5 km boundary. This means the facility contribution at 1.5 km is 38.3 dBA, with an ASL of 35.

3) Compliance of the proposed facility is assessed at the points of intersection of the 1.5 km boundaries (see points A and B in Figure 9). Where no dwelling is present, the 1.5 km boundary becomes merged.

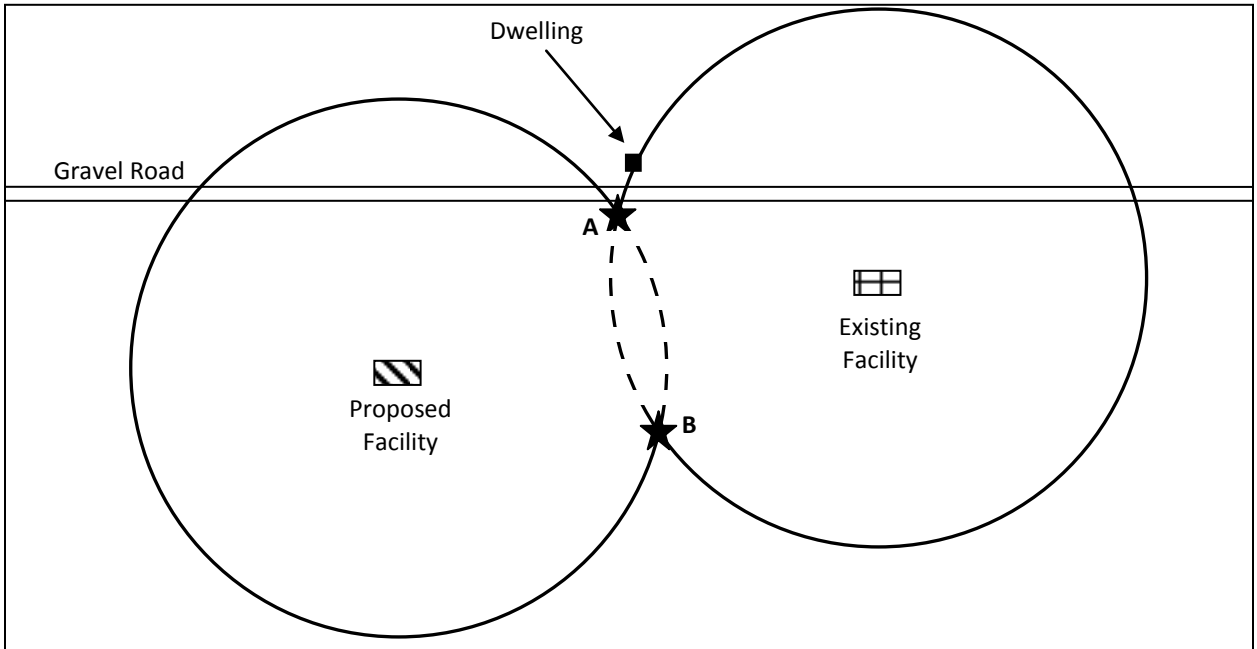


Figure 9 - 1.5 km criteria boundary for example 3

Legend
- Applicable 1.5 km criteria boundary
- Interlaced Area
- 1.5 km criteria boundary Intersection Points

4) The sound emission from the proposed facility needs to be established. The measurements from a similar facility indicate that it is a simple source that emits a sound level of 56.5 dBA at 25 m from the facility property. Using the standard distance attenuation formulae (Appendix 2 - Section 2.5), 56.5 dBA at 25 m results in a noise contribution at point A or B of 20.4 dBA. For more complex sources or situations, the acoustical practitioner must conduct the calculations using modeling software or more detailed calculations to incorporate more attenuation factors.

5) As point A is nearest a dwelling that is affected by the existing facility, the assessment is focused on compliance at point A. Cumulative effects assessment considers the contributions of all energy-related regulated facilities plus the assumed ASL. Noise values at the point of analysis are added using the formula or equation outlined in Appendix 2 - Section 2.4. In this scenario, the result is:

   Proposed Facility + Existing facility + ASL = dBA at Point A

   which is

   20.4 dBA + 38.3 dBA + 35.0 dBA = 40.0 dBA at Point A

6) As the dwelling is located at a distance further away from the proposed facility, the contribution is expected to be less than 20.4 dBA presented in the section above. Using the standard distance attenuation formulae (Appendix 2 - Section 2.5), the proposed facility noise contribution at the dwelling is 18.8 dBA. For the dwelling, compliance is determined by adding the proposed facility contribution to the existing facility contribution and ambient sound level for both the 1.5 km boundary and the dwelling, then comparing the result to the nighttime PSL:

   Proposed Facility + Existing facility + ASL = dBA at the dwelling
   which is

   18.8 dBA + 38.3 dBA + 35.0 dBA = 40.0 dBA at the dwelling

   There are no dwellings within 1.5 km of the proposed facility. AUC Rule 012 limits the nighttime permissible sound level along the 1.5 km boundary. A proposed facility which meets the permissible sound level at the 1.5 km boundary intersection points (points A and B) is expected to have less noise impact at a dwelling located further from the intersection points as well as the 1.5 km proposed facility boundary.

7) The noise impact assessment supplied for this scenario provides the details required according to Section 3 of this rule and outlines the assumptions made and data sources or formulae used.

Solution B

If the proposed facility cannot demonstrate there is “no net increase” at the 1.5 km boundary, there is potential, in this scenario, for cumulative effects to occur at the points of intersection along the 1.5 km boundaries as well as at the dwelling 1.8 km from the proposed facility.

In this scenario, the proposed facility is expected to contribute some noise at the 1.5 km boundary. Therefore, a measurement program has been undertaken at the dwelling, even though it is outside the 1.5 km boundary of the proposed facility. This measurement will be used to establish the existing facility contribution at the dwelling and at the 1.5 km boundary for the existing facility.

In the absence of measured data, theoretical evaluation of the existing facility or even the assumption of compliance with the permissible sound level may be used to estimate the contribution of the existing facility. However these methods may also introduce additional uncertainty or conservatism in the evaluation, resulting in a commitment for greater noise control from the proponent to ensure compliance. The best approach would vary on a case-by case basis, as determined by the acoustical practitioner.

The dwelling is being considered in this assessment as a precautionary measure, due to the expectation of noise contributions from the proposed facility.

1) The permissible sound level at the dwelling is 40 dBA nighttime and 50 dBA daytime, based on a Category 1 dwelling density and the absence of heavily travelled transportation routes. The permissible sound level at the 1.5 km boundary of the proposed facility is 40 dBA nighttime. As the more stringent criteria occur at night, the focus of the assessment will be on compliance during nighttime hours.

2) The comprehensive sound level survey at the dwelling yielded a nighttime L_{eq} of 39.2 dBA and a daytime L_{eq} of 46.1 dBA. These are the representative, isolated results which consist of data collected when the dwelling was downwind of the existing facility and isolated noise events (a lawnmower at the dwelling, dog barking near the instrument) removed. The facility was confirmed with the owner as operating normally. These values represent the cumulative value of the existing facility contribution and the AUC mandated ambient sound level. By subtracting the nighttime ambient sound level from the nighttime comprehensive sound level, the facility contribution at the dwelling and at 1.5 km can be established:

    Comprehensive sound level- ambient sound level = Existing Facility Contribution

    For nighttime: 39.2 dBA – 35.0 dBA = 37.1 dBA Existing Facility Contribution

3) The proposed facility is a power plant with multiple sources. An acoustic model has been constructed using a combination of manufacturer and theoretical data. All calculations were made according to the ISO 9613 standard. Results from the acoustic model indicate the proposed facility will contribute 32.3 dBA L_{eq} nighttime at 1.5 km and 30.1 dBA L_{eq} nighttime at the dwelling.

4) Compliance of the proposed facility is assessed at the points of intersection of the 1.5 km boundaries (see points A and B in Figure 9) and at the potentially affected dwelling. The focus is on point A, as it is the point of intersection nearest the identified dwelling. Compliance is determined by adding the proposed facility contribution to the existing facility contribution and ambient sound level for both the 1.5 km boundary and the dwelling, then comparing the result to the nighttime permissible sound level :

   Proposed Facility + Existing facility + ASL = dBA L_{eq}

   For the 1.5 km boundary: 32.3 dBA + 37.1 dBA + 35.0 dBA = 40.0 dBA

   For the dwelling: 30.1 dBA + 37.1 dBA + 35 dBA = 39.7 dBA

   Compliance at the point of intersection of the 1.5 km boundaries implies compliance at the dwelling in this case.

5) The noise impact assessment supplied for this scenario provides the details required according to Section 3 of the AUC Rule 012 and outlines the assumptions made and data sources or formulae used.

Appendix 7 – References

Document Reference	Title
ANSI S1.11-2004 (R2009)	Octave-Band and Fractional-Octave-Band Analog and Digital Filters
ANSI S1.40-2006	American National Standard Specifications and Verification Procedures for Sound Calibrators
ANSI S1.4-1983 (R2006)/ANSI S1.4a-1985 (R2006)	American National Standard Specification for Sound Level Meters
ANSI S1.26-1995 (R2004)	Calculation of the Absorption of Sound by the Atmosphere
ANSI S1.13-2005 (R2010)	Measurement of Sound Pressure Levels in Air
ANSI S12.18 (R2009)	Outdoor Measurement of Sound Pressure Level
ASTM E1014 – 08	Standard Guide for Measurement of Outdoor A-Weighted Sound Levels
ASTM E1686 – 10	Standard Guide for Applying Environmental Noise Measurement Methods and Criteria
ISO 1996-1 (2003)	Acoustics -- Description, measurement and assessment of environmental noise -- Part 1: Basic quantities and assessment procedures
ISO 1996-2 (2006)	Acoustics -- Description, measurement and assessment of environmental noise -- Part 2: Determination of environmental noise levels
ISO 9613-1:1993	Acoustics -- Attenuation of sound during propagation outdoors – Part 1 Calculation of the Absorption of Sound by the Atmosphere;
ISO 9613-2:1996	Acoustics -- Attenuation of sound during propagation outdoors – Part 2 General method of calculation
IEC 61672-1 ed1.0 (2002.05)	Electroacoustics – Sound Level meters – Part 1: Specifications
IEC 61672-2 ed1.0 (2003-04)	Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests
IEC 61400-11 ed2.0 (2002-12) IEC 61400-11-am1 ed2.0 (2006-05) IEC 61400-11 ed2.1 Consol. with am1 (2006-11)	Wind turbine generator systems - Part 11: Acoustic noise measurement techniques Amendment 1 - Wind turbine generator systems - Part 11: Acoustic noise measurement techniques
IEEE C57.12.90-2010	IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
Harmonoise HAR32TR-040922-DGMR20 (January 2005)	Harmonoise WP 3 Engineering method for road traffic and railway noise after validation and fine-tuning

Note: The references listing provided in the table is not a comprehensive listing of all available references accepted by the AUC. The reader should verify that the latest version of the reference is used

Appendix 8 – Sound definitions table

The following table depicts the sound definitions.

NOISE ROOM REMAINING (IF ANY) TO THE **PERMISSIBLE SOUND LEVEL** (PSL see TABLE 1 AND 2)	**Night time PSL** range from 30 dBA to 66 dBA (Table 1 & 2)	**Day time PSL** range from 40 dBA to 76 dBA (Table 1 & 2)
CUMULATIVE SOUND LEVEL PREDICTED (INCLUDES COMPREHENSIVE)	**NOISE SOURCES** **Facility proposed in Application to AUC**	**EXAMPLES** -Power plants incl. wind farms, cogeneration -Power transformer station -Gas compressor station -Gas regulating/meter station
	Approved but not yet constructed energy-related facilities (all authorities)	- Oil & gas processing plant -Oil battery, pump jack -Oil pump station -Coal mine -Compressor station
COMPREHENSIVE SOUND LEVEL MEASURED (INCLUDES AMBIENT)	**Existing energy-related facilities approved by AUC**	-Power plants incl. wind farms, cogeneration -Power transformer station -Gas compressor station -Gas regulating/meter station
	Existing energy-related facilities approved by others (all authorities)	-Oil & gas processing plant -Oil battery, pump jack -Oil pump station -Coal mine -Compressor station
AMBIENT SOUND LEVEL MEASURED (ENERGY–RELATED NOISE IS ISOLATED OUT OF MEASURED NOISE)	Non energy-related facilities	-Manufacturing plants -Gravel pit operations -Commercial plants
	Non-industrial noise sources	-Vehicular traffic -Dwelling density -Rail lines -Aircraft flyover

- **BASIC SOUND LEVEL** Assumed ambient plus 5 dBA allowed for existing and proposed energy-related facilities.
- If the measured ambient is higher or lower than the assumed ambient, an A2 adjustment may be applicable per Table 2.
- Noise from wind is not included in the ambient sound level.