MEASURED C-WEIGHTED AMBIENT SOUND LEVELS FOR USE WITH ENVIRONMENTAL NOISE REGULATIONS IN ALBERTA AND BRITISH COLUMBIA

Victor W. Young *1, Zhaohui Yu †1 and Andrew C. Faszer ‡1
[1]Golder Associates Ltd. 102, 2535 3 Avenue SE, Calgary, Alberta, T2A 7W5

1 Introduction

Noise Impact Assessments (NIAs) for industrial facilities in Alberta are typically conducted in accordance with Alberta Energy Regulator (AER) Directive 038 [1] or Alberta Utilities Commission (AUC) Rule 012 [2]. Both regulations assess noise cumulatively and require that the contribution of natural and non-industrial sources be included when testing noise compliance for industrial facilities. Noise regulations in British Columbia (BC) are very similar [3].

The Alberta regulations and the comparable BC regulation require that A-weighted and C-weighted cumulative noise levels be compared. A difference between C-weighted and A-weighted noise levels greater than or equal to 20 is considered indicative of a potential Low Frequency Noise (LFN) issue.

Both Alberta regulations and the comparable BC regulation provide desktop techniques for estimating the A-weighted Ambient Sound Level (ASL) associated with natural and non-industrial noise sources. The problem is that these regulations do not provide a methodology for estimating C-weighted ASL values. As such, it is difficult to apply the LFN test using cumulative noise levels and instead NIAs often consider a facility in isolation when testing for LFN issues. This can lead to potential LFN issues being identified even when facility noise levels are very low – so low that they would be completely obscured by the background ASL if it could be included in the LFN test.

This paper establishes a link between A-weighted and C-weighted ASL values for three classes of noise receptors: remote areas far from human activity; isolated rural dwellings; and dwellings adjacent to noisy roads. C-weighted ASL values that can be used in conjunction with the A-weighted ASL values when applying regulatory LFN tests are presented. Links between A-weighted and C-weighted ASL values are established by examining measured noise spectra from 15 receptor locations.

2 Regulatory Context

AER Directive 038, AUC Rule 012, and the comparable BC regulation are all very similar. All three require a cumulative assessment of noise levels at receptor locations corresponding to occupied dwellings. In all three regulations, A-weighted ASL values at receptors are estimated via the same desktop technique, which accounts for time of day, population density, and proximity to transportation infrastructure. ASL values calculated using this technique can range from 35 A-weighted decibels (dBA) to 61 dBA. The minimum ASL value corresponds to the nighttime period (i.e., 10 pm to 7 am) at a receptor located in an area with population density less than nine dwellings per quarter section and more than 500 metres from heavily travelled roads or rail lines. The maximum ASL value corresponds to the daytime period (i.e., 7 am to 10 pm) at a receptor located in an area with population density greater than 160 dwellings per quarter section and less than 30 metres from heavily travelled roads or rail lines.

The exact process by which the regulatory bodies established the desktop technique for calculating ASL values is rather obscure, but seems to be based on field measurements conducted in the 1970s on behalf of the Alberta Department of the Environment [4]. Wherever the original ASL data came from, the professional experience of this paper's authors is that the desktop technique does a reasonably good job of establishing ASL values for most situations. As such, the purpose of this paper is not to challenge the A-weighted ASL values obtained using the desktop technique. Instead, the purpose of this paper is to establish complementary C-weighted ASL values that can be used when applying the LFN test. In particular, this paper seeks C-weighted ASL values to complement the A-weighted ASL values for the receptor classes presented in Table 1.

Receptor Class	Regulatory Daytime ASL	Regulatory Nighttime ASL
A – remote area far from any human activity	45 dBA	35 dBA
B – occupied dwelling more than 500 metres from busy roads or rail lines in an area with population density less than nine dwellings per quarter section	45 dBA	35 dBA
C – occupied dwelling located between 30 metres and 500 metres of a busy road in an area with population density less than nine dwellings per quarter section	50 dBA	40 dBA

Table 1: A-weighted ASL values for three receptor classes

3 Data and Analysis

3.1 Methodology

Golder Associates Ltd. (Golder) has been conducting noise monitoring in Western Canada for more than a decade and during that time has built up an extensive measurement database, which was sampled for this paper. Monitoring

* victor_young@golder.com
† zhaohui_yu@golder.com
‡ andrew_faszer@golder.com

data for five class A receptors, five class B receptors, and five class C receptors were identified as being representative of the range of environmental conditions observed at these receptor classes, and were processed to establish a link between A-weighted and C-weighted ASL values.

The raw monitoring data for each receptor consisted of a series of one-third octave-band noise spectra, with each spectra representing a one-minute energy equivalent noise level ($L_{eq,1min}$). To capture circadian variations in noise levels and noise sources, daytime and nighttime data were considered separately for each receptor.

All monitoring data considered in this paper were collected in accordance with AER Directive 038, AUC Rule 012, or the comparable BC regulation using an appropriately-calibrated Type I integrating sound level meter. Likewise, all monitoring data were filtered in accordance with regulatory guidance to remove invalid noise sources, such as rain on the microphone. As a result of this filtering process, there were periods for some class B receptors where data were not available.

The individual one-minute spectra were weighted and the spectral values were summed to obtain a series of $L_{eq1,min}$ values in dBA and C-weighted decibels (dBC). All available $L_{eq,1min}$ values for a given receptor were plotted on a dBC vs. dBA scatter plot and a statistical t-test was used to check the significance of the correlation between dBA and dBC values. For all receptors, the correlation was found to be both strong and significant.

Linear regression was separately used to fit the dBC vs. dBA data for each receptor. The regression coefficients were then used to predict complementary C-weighted ASL values for use with the A-weighted ASL values presented in Table 1. A statistical t-test was used to establish 95% confidence bounds on the predicted C-weighted values for each receptor. Individual predictions for each receptor class were then averaged, using the 95% confidence bounds as uncertainty weights, to obtain C-weighted ASL values representative of the class as a whole.

3.2 Results

Table 2 presents results for receptor class A – remote area far from any human activity. Table 3 presents results for receptor class B – isolated dwelling. Table 4 presents results for receptor class C – occupied dwelling adjacent to a noisy road.

Receptor	C-Weighted ASL for use with 45 dBA	C-Weighted ASL for use with 35 dBA
A1	47 ± 7 dBC	38 ± 4 dBC
A2	57 ± 10 dBC	34 ± 3 dBC
A3	51 ± 6 dBC	47 ± 4 dBC
A4	51 ± 7 dBC	44 ± 3 dBC
A5	53 ± 11 dBC	37 ± 2 dBC
Weighted Average	*51 dBC*	*39 dBC*

Table 2: Results for Receptor Class A

Receptor	C-Weighted ASL for use with 45 dBA	C-Weighted ASL for use with 35 dBA
B1	49 ± 6 dBC	43 ± 7 dBC
B2	52 ± 10 dBC	no valid nighttime data
B3	no valid daytime data	43 ± 3 dBC
B4	53 ± 8 dBC	40 ± 6 dBC
B5	50 ± 9 dBC	41 ± 5 dBC
Weighted Average	*51 dBC*	*42 dBC*

Table 3: Results for Receptor Class B

Receptor	C-Weighted ASL for use with 50 dBA	C-Weighted ASL for use with 40 dBA
C1	53 ± 3 dBC	50 ± 5 dBC
C2	58 ± 6 dBC	53 ± 6 dBC
C3	59 ± 7 dBC	53 ± 6 dBC
C4	64 ± 8 dBC	61 ± 7 dBC
C5	58 ± 7 dBC	49 ± 8 dBC
Weighted Average	*56 dBC*	*53 dBC*

Table 4: Results for Receptor Class C

4 Discussion

By analyzing $L_{eq,1min}$ spectra measured at 15 different receptor locations, this paper has established C-weighted ASL values that can be used in conjunction with A-weighted ASL values when performing a regulatory LFN test.

The authors do not claim that the C-weighted ASL values presented in this paper are true or accurate representations of C-weighted noise levels that would be observed for a particular receptor or receptor class. Indeed, the variability inherent in the environment at most receptors makes characterization of noise levels by a single number effectively impossible. Instead, the authors claim that the C-weighted ASL values presented in this paper are an appropriate match for A-weighted ASL values calculated using the desktop technique described in AER Directive 038, AUC Rule 012, and the comparable BC regulation.

It is hoped that use of the C-weighted ASL values presented in this paper when applying the LFN test will reduce the number of false-positives that often occur when facility noise levels are predicted to be low, and thereby allow for a more realistic assessment of LFN issues in future NIAs conducted in Alberta and BC.

References

[1] Energy and Utilities Board. 2007. Directive 038: Noise Control. Approved February 16, 2007.

[2] Alberta Utilities Commission. 2013. Rule 012: Noise Control. Effective April 1, 2013.

[3] BC Oil and Gas Commission. 2009. British Columbia Noise Control Best Practices Guideline. Issued March 2009.

[4] Bolstad Engineering Associates Ltd. 1977. Compressor Station and Gas Plant Noise Emission. Prepared for Alberta Department of the Environment.