Modelled Trends in Environmental Noise Levels as a Function of Long-Term Meteorology in Alberta

Jerome Parkinson and Jason McCrank
HFP Acoustical Consultants Corp., Suite 1140, 10201 Southport Road SW, Calgary, AB , Canada, T2W 4X9
info@hfpacoustical.com

1. INTRODUCTION

Environmental noise surveys in rural settings are commonly conducted in Alberta. A frequently encountered scenario is that of a listener located near an industrial facility with no other sources of continuous noise nearby. When surveys are conducted to measure the noise level occurring at the listener's location, it is found that the noise level varies as a result of changes in meteorological conditions.

The current investigation looked at the predicted noise level for listeners located 1 km from a noise source with a sound power spectrum of a typical natural gas compressor station. Hourly meteorological data for a 5 year period was used to predict 43,824 hourly Leq noise levels at listener locations. The predictions were made for listeners 1 km away from the noise source in 4 cardinal wind directions. Meteorological data from 6 distinct air sheds was investigated. The purpose of the exercise was to investigate long-term trends in the hourly noise levels as a function of meteorology.

2. METHOD

An analytical algorithm was used to model the propagation of noise from the source to the listeners and to predict the noise levels at the listener locations. A predictive model had several advantages over real long-term measurements. Most real world noise surveys require extensive analysis to isolate the noise level of a single source from other sources of noise. With modelled noise levels, it was possible to analyze the idealized scenario of a listener near an industrial noise source with no other source of noise to contribute to or contaminate the noise level. With a model it was feasible to predict five years of hourly sound levels. It would not have been realistic to collect five years of real hourly sound levels. Finally, it was feasible to predict hourly noise levels in four different directions for locations in 6 different air sheds.

All predictive algorithms face the question of how well they model reality. It would have been ideal to compare the predicted noise levels of this investigation to real world data. However, it would have been impractical to acquire the data that would have been required for such a comparison. "The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities" algorithm as developed by the CONCOWE Special Task Force on Noise Propagation was used to predict the noise levels. This algorithm is specific to petroleum sector facility noise which is the most common source of environmental noise concern in Alberta. It was also selected as the algorithm for this study because it accounts for the influence of meteorological stability category.

Hourly meteorological data was obtained from Environment Canada's Meteorological Services Division. Hourly wind speeds, wind directions, relative humidities, and temperatures were obtained for five years from six air sheds encompassing the Edmonton Namao, Calgary, Red Deer, Medicine Hat, Edson, and Peace River airports. The corresponding Pasquill stability classes for each hour in each air shed were obtained from Alberta Environment.

3. RESULTS

A set of hourly Leq dBA noise levels was generated for a listener located 1 km from the noise source in four cardinal wind directions (north, east, south, and west) for the six air sheds. The result was 24 sets of data that each encompassed 43,824 hourly Leq noise levels. The data was assessed using various statistical and graphical tools to identify trends and draw conclusions.

4. DISCUSSION

4.1 Total data set

In all sets of data, it was found that the Leq's of nighttime noise levels (10pm to 7am) were higher than daytime noise levels. The nighttime Leq's were on average 1.0 dBA higher than daytime noise levels.

Figure 1 illustrates a typical distribution of hourly Leq's at a listener location. In this example, the lowest hourly noise level was 21.2 dBA and the highest hourly noise level was 40.8 dBA in this example. The standard deviation of all hourly noise levels in the data was 4.5 dBA. The variation in hourly noise levels is relatively large.

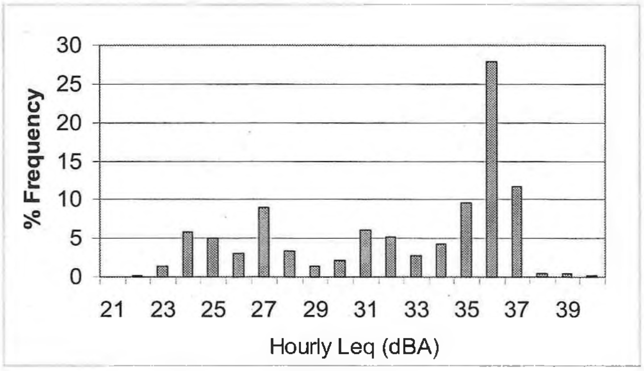

Figure 1. Frequency of representative hourly Leq noise levels as a percentage of the total hourly Leq noise levels for a listener 1 km east of a typical compressor station in the Peace River air shed.

In the data shown in Figure 1, the standard deviation in the daytime (7am to 10pm) hourly noise levels was 4.6 dBA. The standard deviation in the nighttime (10pm to 7am) hourly noise levels was 4.2 dBA. These standard deviations were typical of all locations and air sheds. In all locations for all air sheds the standard deviation in the nighttime noise levels was less than in the daytime noise levels. This indicates that the variation in nighttime noise levels is less than the variation in daytime noise levels.

In all six air sheds, it was found that the Leq noise levels for a listener to the east of the noise source was higher than for a listener to the north, south, or west of the source. This trend was observed in the total noise levels, the daytime noise levels, and the nighttime noise levels. As Alberta has a predominant westerly wind, this observation was not surprising.

4.2 Data from 'representative nights'

Real surveys of industrial environmental noise generally focus on nighttime noise levels because this is when the other masking sound is lowest, listeners are more commonly trying to rest, and regulations for noise levels are most strict. Conscientious noise surveys are done under meteorological conditions which are likely to capture a sample of the noise levels which listeners are concerned about. The Alberta Energy and Utilities Board, which regulates energy sector environmental noise levels, refers to noise levels which represent the noise of concern as 'representative noise levels'. An investigation was conducted into the variations and trends in Leq nighttime noise levels that occur during meteorological conditions which would be considered 'representative'.

The conditions that define 'reprentativeness' are not precisely defined. However, the general assumption is that a wind direction which puts the listener directly downwind or crosswind of the noise source is likely to be representative. Periods of high wind speed are also not considered representative because it is practically impossible to take quality noise measurements in such conditions. For the current analysis, a nighttime Leq noise level was considered to be representative if at least 7 hours in the 9 hour nighttime period met the condition of being downwind, partially downwind, or precisely crosswind from the source to the listener and the wind speed was less than 20 km/hr.

Figure 2 shows a typical distribution of representative nighttime noise levels (9 hour Leq). In this example, the lowest representative nighttime noise level was 29.4 dBA while the highest was 40.6 dBA. The standard deviation for these representative nighttime Leq's was 1.2 dBA. The distribution indicates that it is more common for a representative nighttime noise level to fall below the average representative nighttime noise level. The variation in representative nighttime noise levels is relatively small. All 24 data sets showed very similar trends.

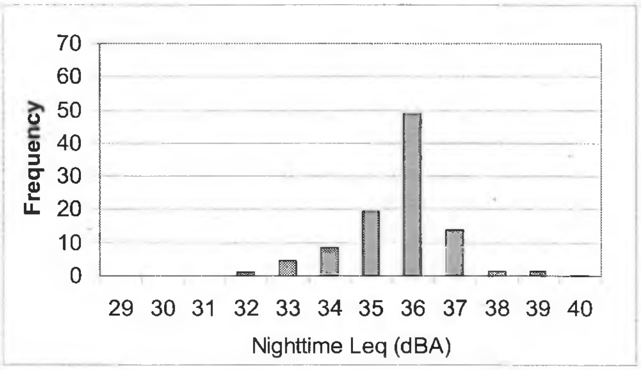

Figure 2. Frequency of representative nighttime Leq noise levels as a percentage of the total number of representative nights for a listener 1 km east of a typical compressor station in the Peace River air shed.

It was found in all air sheds that a listener to the east of the noise source was up to 22 times more likely to experience "representative conditions" than a listener to the north, south, or west of the noise source. People living to the east of an industrial facility will experience high industrial noise levels far more commonly than people living in other directions from the facility in Alberta.

REFERENCES

Manning, C.J. (1981) "The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities", CONCOWE's Special Task Force on Noise Propagation, (CONCOWE is the oil companies European organization for environmental, health, and safety).