COMPARISON OF AIRCRAFT NOISE EXPOSURE FROM NEF CONTOURS AND FIELD MEASUREMENT RESULTS

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1 Introduction

Noise due to by Vancouver International Airport (YVR) aircraft activities is of major concern for the public in the City of Richmond, British Columbia. Acoustical consultants commonly use the Noise Exposure Forecast (NEF) contours provided by Vancouver Airport Authority (YVRAA) to assess the impact of aircraft noise on new residential developments, which are regulated using the 24-hour equivalent sound level (L_{eq24}) metric. This is because it is quicker to rate a site's noise exposure by reviewing the NEF contours than by performing site noise measurements that are correlated with aircraft movements during that time.

The development of NEF contours is mandated by Transport Canada for planning purposes and are developed using the peak planning day of the forecast year, which, in this case, was 2015. The National Research Council of Canada (NRC) has previously estimated that the typical difference between the NEF and the corresponding 24-hour equivalent sound level is 32. [1]

BKL has performed 24-hour noise measurements in the City of Richmond and found that aircraft noise levels at those measurement locations tended to be significantly lower than would otherwise be assumed using the NRC estimate. Therefore, BKL has investigated the difference in aircraft noise exposure between the published NEF contours and noise measurement results.

2 Method

2.1 Selection of Noise Comparison Locations

YVR maintains a set of permanent Noise Monitoring Terminals locations (NMTs) for their long-term noise monitoring program. Data from these NMTs was made available to BKL by YVRAA for the purposes of this comparison. While aircraft noise is dominant at some of these locations, noise from local activities such as traffic is dominant at other locations. The first step of BKL's analysis focused on the selection of noise monitoring locations where aircraft noise is predominant in order to improve the accuracy of the comparison.

YVRAA publishes annual noise reports as part of their noise monitoring program. Two noise levels have been published in some of these reports: the equivalent total noise level and the equivalent aircraft noise level. The aircraft noise level is automatically calculated by the NMT system according to aircraft flyover (level and duration) characteristics.

BKL reviewed the past annual reports and selected the following best available locations as labelled in Figure 1.

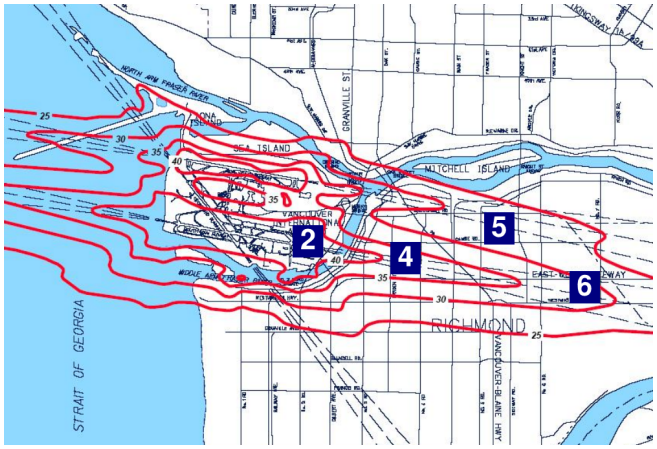

Figure 1: Selected NMT Site Locations where Aircraft Noise is Dominant

2.2 NMT Measurements

All of YVRAA's NMTs use Bruel & Kjaer Model 2250 Type 1 sound level meters. YVRAA provided BKL with daily aircraft noise monitoring data collected for the entire month of August 2015 at the NMT locations noted above, except at site 6 where data from August 2-5 was unavailable. The month of August was chosen since August is the busiest month of the year. BKL used the measured aircraft noise levels for the purposes of this comparison.

2.3 Predictions Using NEF Contours

NEF values were determined at each location using the YVR forecast 2015 NEF contours. The predicted aircraft noise level was estimated using the following equation:

$$L_{eq24,NEF} = NEF\ value + 32$$

3 Results

The summary of August 2015 measurement results at NMT sites 2, 4, 5 and 6 as well as the predicted $L_{eq24,NEF}$ values at these locations can be found in Table 1 below. The noise levels shown in Table 1 are the aircraft noise levels.

It is readily observed that the predicted aircraft noise levels using the NEF contours are higher than the measured values. The details of the differences can be found in Table 2.

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Table 1: Summary of August 2015 measurement results and predicted $L_{eq24,NEF}$ values at these measurement locations

NMT Site	August 2015 Measured Aircraft $L_{eq24,NMT}$		2015 NEF Contour Prediction	
	Average (dBA)	Maximum (dBA)	2015 NEF	$L_{eq24,NEF}$ (dBA)
2	61.4	68.2	> 40	> 72
4	57.4	62.8	35.0	67.0
5	54.8	57.4	27.7	59.7
6	53.3	56.4	32.2	64.2

Table 2: Summary of differences in August 2015 measurement results and predicted $L_{eq24,NEF}$ values at these measurement locations

NMT Site	Difference from Measured Average Value	Difference from Measured Maximum Value
2	>10.6	>3.8
4	9.6	4.2
5	4.9	2.3
6	10.9	7.8

The differences shown in Table 2 above are only for the average and maximum daily aircraft noise levels in the month of August 2015. Variations on a day-to-day basis can help visualize the range of differences. Figure 2 below shows the difference between measured daily aircraft noise levels and the NEF predicted levels at the NMT sites.

The error is defined as:

$$Error = L_{eq24,NEF} - L_{eq24,NMT}$$

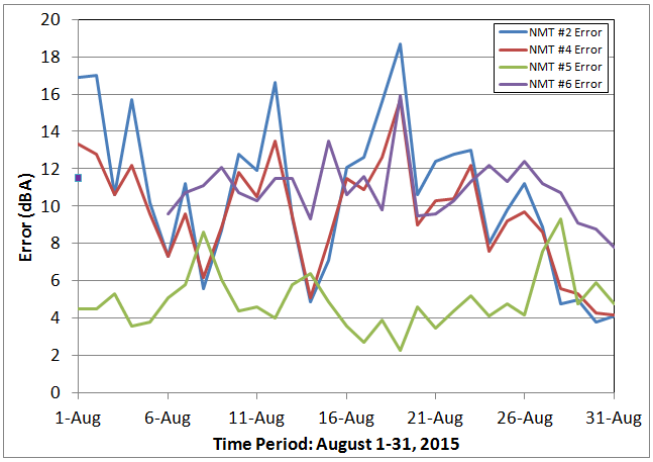

Figure 2: $L_{eq24,NEF}$ Error at NMT Locations During Peak Month

Data was unavailable from August 2 to August 5, 2015 at NMT site 6. From all of these four long-term NMT stations, aircraft noise predicted by NEF contours was most conservative at NMT site 5 and was least conservative at NMT site 2. The maximum error at NMT site 2 is 18.7 dBA while the minimum error at NMT site 5 is 2.3dBA. Therefore, the error of estimating aircraft noise levels by using NEF contours ranges from 2.3 dBA to 18.7 dBA during August 2015.

4 Discussion

NMT sites 2, 4, 5 and 6 are located in areas that have aircraft noise as a dominant noise source. The L_{eq24} noise levels predicted using the 2015 NEF contours plus 32 were more conservative in all cases, by at least 2.3 dBA.

One reason for the disparity is that the number of 2015 forecast aircraft movements was significantly higher than the number of actual movements. [2] Another is due to the accuracy of the software used to calculate NEF values. [1]

On one hand, a conservative estimate of aircraft L_{eq24} noise exposures would lead to better noise isolation to be installed at new residential developments that are affected by aircraft noise in the City of Richmond.

On the other hand, the conservative approach could increase construction costs significantly in some cases, resulting in higher housing costs. Returning to the least conservative case in BKL's analysis, the 2.3 dBA over-estimation with regards to aircraft noise levels can still be the difference between normal and thicker, laminated glazing: a significant cost increase.

5 Conclusion

Noise levels predicted using NEF contours tend to be significantly more conservative than 24-hour continuous site noise measurement results when assessing aircraft noise activities. When NEF predicted noise levels are used to assess aircraft noise for the design of new developments, it is likely that resulting improvement schemes are overly conservative. Therefore, actual site noise levels should be considered during the design of new developments. Professional acoustical consultants can establish a more realistic noise environment and recommend appropriate improvements to meet municipal requirements. This would require more initial effort but could result in significant overall development cost savings.

Acknowledgments

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References

[1] Bradley, J.S. 1996. NEF Validation Study: (3) Final Report. NRC Contract Report to Transport Canada, A1506.6 (1996). Ottawa, National Research Council of Canada.

[2] Vancouver Airport Authority. 2016. 2015 Aeronautical Noise Management Report. Richmond, Vancouver Airport Authority.