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Shortened measurement procedure for road traffic noise at night – revisited.

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ABSTRACT

In the UK there is an established shortened noise measurement procedure for daytime road traffic noise. However there is no standard method for shortened measurements of road traffic noise at night.

This paper investigates two possible shortened methods of measuring road traffic noise at night, one of which is a re-examination of a method devised previously by one of the authors. The investigations are based upon a dataset of 24-hour noise measurements obtained from a number of sites that are exposed to noise from motorways or major roads in the Merseyside region.

The results of the shortened period noise measurements are compared with the actual 8-hour measured values. Regression analysis is carried out to establish and compare the accuracy of the two methods.

1. INTRODUCTION

When considering the potential impact of existing road traffic noise on proposed new residential developments in England it is necessary to follow the guidance in Planning Policy Guidance Note 24 'Planning and Noise' 1994[1] (PPG 24). This document requires the traffic noise to be assessed in $L_{Aeq,T}$ for daytime and night-time periods which are defined as 0700-2300 hours and 2300-0700 hours respectively. Similar guidance applies in Scotland[2] and Wales[3].

Ideally, traffic noise levels should be measured over the entire 16-hour daytime and 8-hour night-time periods. This is usually straightforward, and cost effective, to do in those situations where the development site is safe and secure such that automated noise monitoring equipment can be installed. However, many sites do not fall within this category and therefore 'attended' noise monitoring is necessary. Carrying out attended monitoring over a 24 hour period (i.e. by 3 consultants working a shift system) is labour intensive and costly. Therefore, where possible, it is beneficial to use a shortened measurement procedure as long as the results can be expected to give an accurate representation of the actual 16-hour daytime and 8-hour night-time noise levels.

For daytime traffic noise an established shortened measurement procedure already exists in the UK. This is the 3-hour measurement procedure set out in the Department of Transport Memorandum 'Calculation of Road Traffic Noise', 1988[4] (CRTN). The CRTN method expresses traffic noise in terms of $L_{A10(0600\text{-}2400)}$ but this can be readily converted to $L_{Aeq(0700\text{-}2300)}$.

However, no such formal shortened measurement procedure exists for evaluating road traffic noise at night. Consequently, most consultancy firms, including Hepworth Acoustics, have developed their own shortened measurement method. Two such methods are investigated in this paper and the results compared with actual 8-hour noise measurement data that was obtained by Hepworth Acoustics as part of the Merseyside Noise Study[5].

2. POSSIBLE APPROACHES

The two approaches that are investigated in this paper:-

- Method A – measuring traffic noise for the first, or last, 3 hours of the night-time period and using the $L_{Aeq(3\ hour)}$ value as a representation of the $L_{Aeq(8\ hour)}$ value.

- Method B – measuring traffic noise for the first or last 2 hours of the night and applying an adjustment to the measured $L_{Aeq(2\ hour)}$ result to obtain a representation of the $L_{Aeq(8\ hour)}$ value.

A. Method A

This method has been used by Hepworth Acoustics for many years for development sites that are located near to busy roads. Ad-hoc comparisons of data from sites where we have obtained data for the whole night have shown a reasonable degree of accuracy.

The approach is based upon the assumption that for well-trafficked roads the noise v time profile will be approximately symmetrical i.e. falling gradually from 2300 hours to a minimum usually between 0200-0400 hours and then gradually rising again to 0700 hours. It therefore follows that the L_{Aeq} value measured over 2300-0300 hours, or 0300-0700 hours, will give a good representation of the $L_{Aeq(8\ hours)}$ value.

For example if the actual $L_{Aeq(2300\text{-}0300)}$ value is 55 dB(A) and the actual $L_{Aeq(0300\text{-}0700)}$ value is 55 dB(A) then the overall night-time $L_{Aeq(2300\text{-}0700)}$ value will of course be 55 dB(A) - thus it is only necessary to measure one half of the night. In practice there seems little point in measuring the quietest hours of the night and so Hepworth Acoustics usually measure the 3 hour period 2300-0200 hours or 0400-0700 hours. For motorways and trunk roads away from city centres we would normally carry out the survey over the 0400-0700 hours period so as to include any early morning goods traffic.

B. Method B

The second method under investigation is a 2-hour measurement procedure that was described in a research paper[6] by S Bird and M Fillery. The paper investigated a possible shortened measurement procedure for traffic noise at night based on an analysis of the national 24-hour noise measurement data obtained in 2000-2001 and published in the National Noise Incident Study[7]. The authors concluded that for sites near to busy roads the following equations can be used to predict the $L_{Aeq(2300\text{-}0300)}$ value from shortened (2-hour) measurements:

$$L_{Aeq(2300\text{ - }0700\text{ hours})} = L_{Aeq(2300\text{-}0100\text{ hours})} + 0.5$$

$$L_{Aeq(2300\text{ - }0700\text{ hours})} = L_{Aeq(0500\text{-}0700\text{ hours})} - 3.5$$

3. ANALYSIS

A. Data

In 2004 Hepworth Acoustics Ltd carried out 24-hour noise measurements at multiple locations across the Liverpool area as part of the Merseyside Noise Study. Surveys were carried out in different types of environmental categories which included motorways and urban/major roads. The NIS data used by Bird and Fillery did not include motorways so the Merseyside data set is useful in this respect.

For the Merseyside Study hourly L_{Aeq} data was obtained at 90 different measurements locations over 24-hour periods. Sifting through the data to exclude sites in rural areas or those near to non-traffic noise sources resulted in 12 sites exposed to motorway noise and 13 sites exposed to noise from urban/main roads. The noise measurements were taken at residential properties at various distances from the roads and therefore are not ‘roadside’ locations. At some locations the distances were considerable and some sites may have been partially screened by intervening buildings or topography. So these are ‘real world’ conditions which reflect the range of development sites that we often have to deal with.

B. Data Analysis

From the hourly data obtained from the Merseyside Noise Study, the actual L_{Aeq} noise levels for 5 different time periods have been calculated:

L_{Aeq} 8 hours between 2300 - 0700 hours
L_{Aeq} 3 hours between 2300 - 0200 hours
L_{Aeq} 3 hours between 0400 - 0700 hours
L_{Aeq} 2 hours between 2300 - 0100 hours (including +0.5 dB correction)
L_{Aeq} 2 hours between 0500 - 0700 hours (including -3.5 dB correction)

To investigate the relationship between the short-term and long-term data statistical analysis has been carried out. This has involved regressions analysis and evaluating 95% confidence values.The standard deviation of the differences between the 2 and 3-hour L_{Aeq} noise levels with the 8-hour L_{Aeq} noise level have enabled us to calculate the range in dB where 95% of the values will fall. The 95% confidence limit is given by 1.96 times the standard deviation.

4. RESULTS

The results of regression analysis for the motorway data for the each of the four time periods are shown in Figure 1.

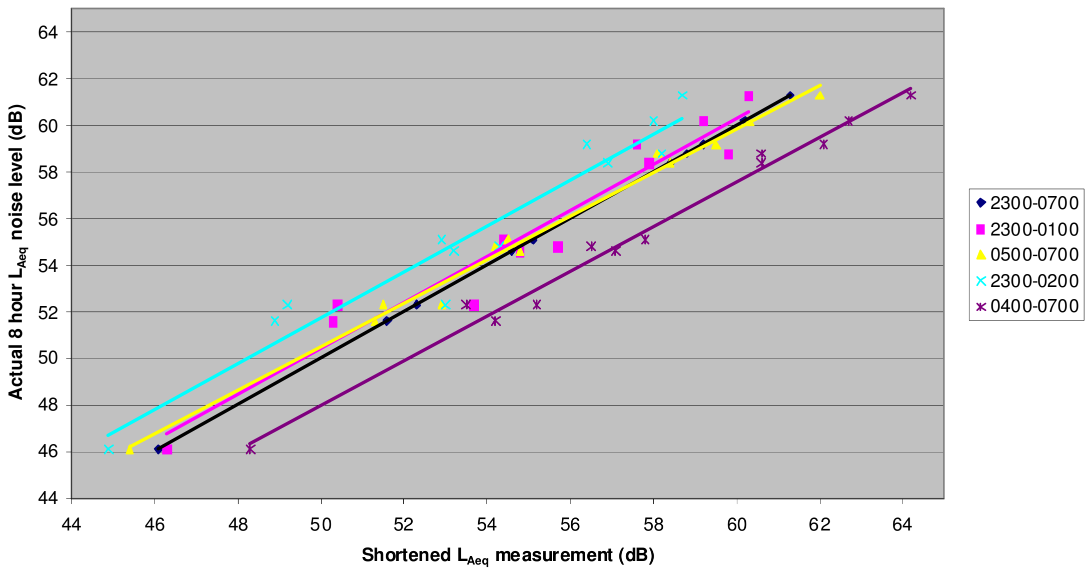

Figure 1: Regressions analysis – motorway noise.

The black line in Figure 1 represents the ideal perfect correlation between the shortened measurements and the actual 8-hour results. The regression lines for the 2300-0100 and 0500-0700 periods (i.e. Method B) are closest to the ideal correlation, although the 2300-0100 results do exhibit some scatter. The 2300-0200 (Method A) data generally show a slight underestimation of the actual 8-hour L_{Aeq} value. The regression line for the 0400-0700 (Method A) period is to the right of the ideal correlation line, thus indicating an overestimation of the 8-hour L_{Aeq} value.

Further analysis of the data for motorways is shown in Figure 2. Figure 2 shows the 95% confidence limits in respect to the actual 8-hour L_{Aeq} noise level. Thus, the top and bottom values are the 95% confidence limits, and the centre value is the average difference of each method to the 8-hour L_{Aeq} noise level.

Figures 2 and 3 show the 95% confidence interval for motorways and urban roads respectively.

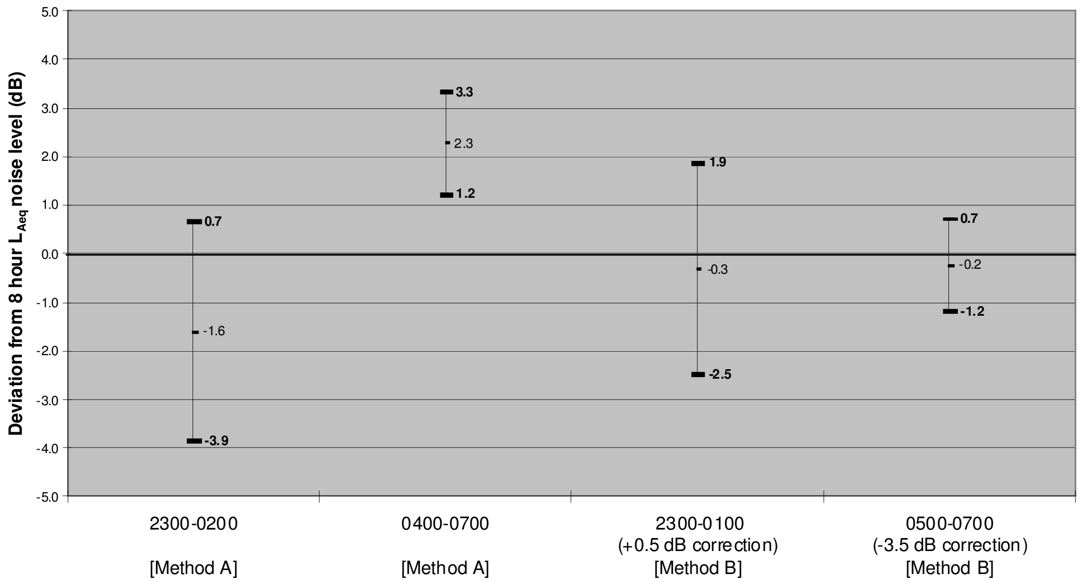

Figure 2: 95% Confidence intervals for motorway noise.

Figure 2 shows that for motorways the most accurate approach was Method B for the 2-hour early morning period (0500-0700 hours minus 3.5 dB) with an average deviation of 0.2 dB(A). The Method B approach for the start of the night (2300-0100 hours plus 0.5 dB) gave a similarly impressive average deviation of only 0.3 dB(A) but with a wider spread of values.

Figure 2 shows that monitoring over 3 hours at the start of the night (2300-0200 hours) can result in an underestimation of the actual 8-hour L_{Aeq} value. Conversely, using Method A for the end of the night shows an overestimation of the actual 8 hour L_{Aeq} value by 1 to 3 dB(A).

The same analysis is carried out for urban roads in Figure 3.

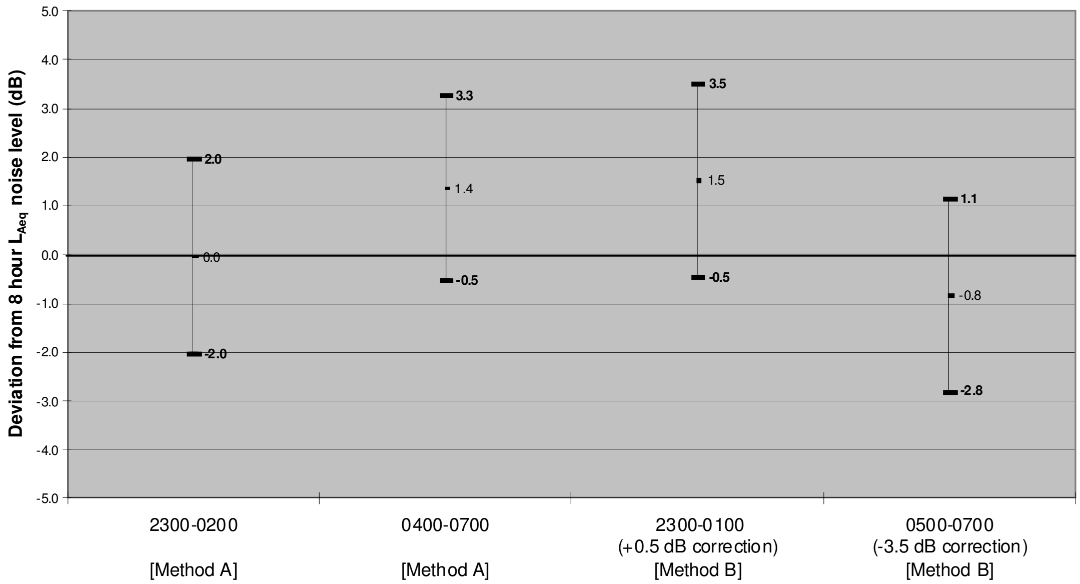

Figure 3: 95% Confidence intervals for urban road noise.

In Figure 3 the Method A (0400-0700) interval generally shows a slight over-prediction of the 8-hour L_{Aeq} value, as does the Method B (2300-0100) approach.

5. SUMMARY AND CONCLUSIONS

This paper has compared two different methods of predicting an 8-hour L_{Aeq} noise level from shorter measurement periods. Method A uses a shortened L_{Aeq} measurement period of the first or last 3 hours of the night to represent the 8-hour night-time L_{Aeq} value. Method B is based upon measuring the L_{Aeq} value over the first or last 2 hours of the night and applying a correction of +0.5 dB for the 2300-0100 period and -3.5 dB for the 0500-0700 period.

The 24-hour noise measurement data for motorways and major roads from the Merseyside Noise Study has been used as a basis for comparing the methods.

Both methods were found to give a reasonable level of accuracy. Method A for the 0400-0700 hours period was found to generally overestimate the actual 8-hour L_{Aeq} value. Thus, using this method would be a conservative approach. However, the results show that greater accuracy (particularly for motorway noise) would be achieved by adopting the Method B approach for the early morning period, i.e. measuring the traffic noise between 0500-0700 hours and deducting 3.5 dB(A).

REFERENCES

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