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VARIABILITY OF NOISE INDICES

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1. INTRODUCTION

An essential part of most environmental noise assessments is the establishement of baseline noise levels upon which the impact of the proposal can be assessed. A noise survey must measure the indices most relevant to that particular assessment methodology. It would appear that consideration is rarely given as to how representative a noise survey may be of the long term temporal distribution of noise levels at a particular site. A particularly topical example of the relevance of this variability is contained within BS 4142: 1990 Method for rating industrial noise affecting mixed residential and industrial areas [1]. The section on measurement of background noise levels contains the following recommendation:

"6.1.2 Ensure that the measurement time interval is sufficient to obtain a representative value of its background noise level.

Note. The measurement time interval is usually at least 5 min."

This recommendation supposes that knowledge exists as to the variability of the L_{A90} background noise level at any site so a judgement can be made as to the length of the sample needed to provide a representative noise value. In reality, knowledge of this rarely exists and a significant short term fluctuation in noise levels can ultimately alter the acceptability of a proposal. It was therefore decided to undertake a study into the variability of noise indices with respect to current noise standards and approved assessment methodologies.

A review of noise standards or methods of assessment commonly in use today determined that there are few standards or criteria which specifically recommend measurement of baseline noise levels. However, the following were found:

1. British Standard 4142;
2. Department of Transport Manual of Environmental Appraisal [2];
3. British Rail's Design Aims for New Railways [3].

The most critical of these is BS 4142 which compares the rating level (the corrected L_{Aeq}) with the measured L_{A90}. The other systems compare the existing noise level with that of the sum of the existing and the new noise, giving an indication of the noise level increase with the new source.

Few studies have been undertaken into this subject area. Other than fairly general references to variations in ambient noise levels, a database search provided only 2 pairs of co-authors who had specifically addressed problems of the variablity in noise levels. Stevenson and Palmer [4] considered variations in the background L_{A90} level in a suburb of Riccarton, New Zealand. This study concluded that: variations in the background noise level of up to 10 dB(A) for the same hour and same weekday could occur; that this variation did not correlate with traffic on local roads; that background noise levels were higher in the winter, and that most variation seems to be due to atmospheric variation. The second study by Driscoll and Webster undertook a number of studies in America and produced a number of papers; [5, 6, 7, 8]. They also considered that significant long-term variations in ambient noise levels are frequently overlooked and can be responsible for errors of 10 dB(A) or more. They produced a method for estimating the number of short samples required to produce noise measurement data with a standard deviation of a certain amount within a 95% confidence limit.

2. NOISE SURVEY SITE

Hourly noise measurements over a six week period were available from a continuous survey at one rural fringe site in the South East of England, undertaken in a major transportation corridor. This site lay within 1 km of the M25, 2 km of the M20/A20, 3 km of the A2 and within 1 km of a main east-west railway line.

3. ANALYSIS

It was decided to analyse the data in two ways, the first to indicate the stability of noise levels over defined time periods and the second to indicate the stability of the standard deviation with time. This analysis was undertaken using the Smart spreadsheet programme on a personal computer and involved many thousand manipulations and calculations. To indicate the stability of noise levels over defined time periods the data set was split into day, evening and night and then sub-split as shown in Table 1 into more specific periods. Once the data had been sorted, the noise levels over each period block were averaged and the standard deviation of the averages obtained. To indicate the stability of the standard deviation with time, the data set was again split into day, evening and night and then rejoined into complete continuous daytime, evening time and night-time data blocks. The standard deviation of an increasing sample time was then derived from the averages.

VARIABILITY IN NOISE LEVELS

Period	Period Length in Hours	Approximate No in Sample	L_{Amax}		L_{A10}		L_{Aeq}		L_{A90}	
			Level	S.D.	Level	S.D.	Level	S.D.	Level	S.D.
Hourly	1	1008	67.8	6.4	53.3	6.9	60.7	6.3	42.4	5.3
Day	12	42	69.8	1.8	53.3	2.1	52.6	1.7	44.4	2.7
Day	1	604	69.8	4.4	53.3	3.1	52.6	2.7	44.4	4.4
Weekday	12	30	69.4	1.9	53.2	2.1	52.3	1.8	44.6	3.0
Weekend Day	12	12	70.9	1.2	53.7	2.2	53.0	1.4	43.8	1.8
Evening	3	42	67.5	8.5	52.0	6.3	49.9	4.3	42.3	5.9
Evening	1	126	67.6	6.6	52.0	5.8	49.9	8.1	42.3	5.9
Weekday Evening	3	30	67.8	4.8	51.8	5.6	48.8	4.5	42.5	5.8
Weekend Evening	3	12	68.1	3.7	52.9	5.2	50.1	4.3	42.1	6.4
Night	9	42	64.8	1.8	51.1	1.8	46.6	1.7	39.8	2.0
Night	1	378	64.8	7.8	51.1	7.7	48.8	8.9	38.9	6.0
Weekday Night	9	30	64.8	1.6	51.1	1.7	48.8	1.9	39.9	2.0
Weekend Night	9	12	64.9	1.8	51.1	2.0	48.8	1.9	39.5	2.6
24 Hour	24	42	67.6	1.3	53.3	2.3	50.6	1.4	42.3	2.3
24 Hour (Weekday)	24	30	67.3	1.4	53.2	1.7	50.8	1.5	42.6	2.4
24 Hour (Weekend)	24	12	68.3	1.3	53.3	1.8	50.6	1.4	42.3	2.3

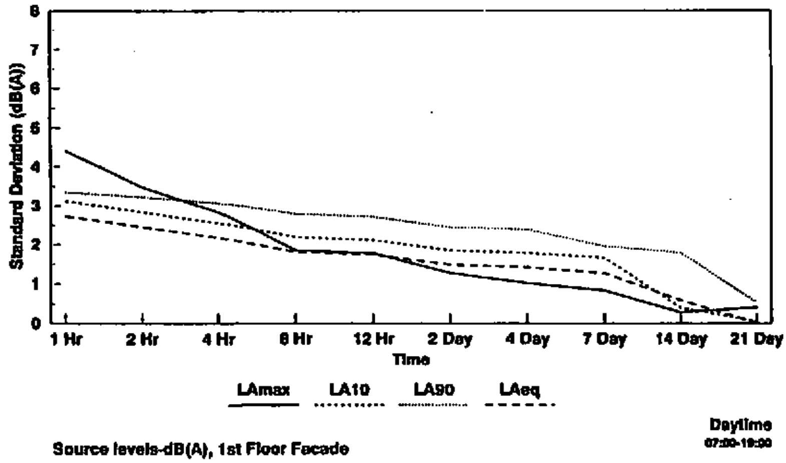
TABLE 1: DISTRIBUTION OF NOISE LEVELS & STANDARD DEVIATION WITH SCALE/INDEX AND PERIOD

4. RESULTS

The analysis of the data indicating the stability of noise levels over defined time periods provided the table mentioned above. This indicated the average noise level for each period and shows the weekend daytime L_{Amax} exhibits the highest noise level and the weekend night-time L_{A90}, the lowest.

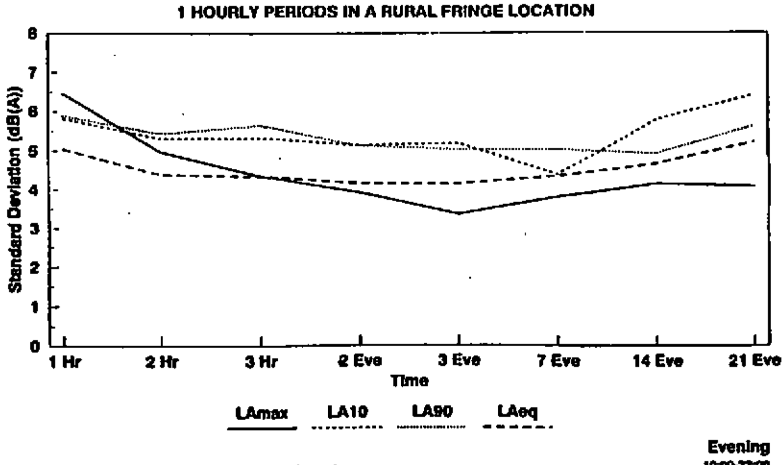
The analysis of the stability of the standard deviation with time produced data which showed that the longer the sample period, the lower the standard deviation of the average noise levels. These were separately derived for daytime, as shown in Figure 1, evening time as shown in Figure 2 and night-time as shown in Figure 3. This analysis indicated that to obtain a daytime L_{A90} with a standard deviation of 2 dB(A) or less, then measurements over 6 days would be required. For evening time the time period was unknown but greater than the survey period, for night-time it was approximately 5 night-time periods.This analysis has indicated the hourly sample length required to provide an average noise level with a known standard deviation and is therefore very useful when undertaking noise survey work in that the required measurement time with reference to variability can be estimated. This analysis has also indicated that the evening time is a particularly poor period over which to undertake measurement which are required to exhibit a low variability.

FIGURE 1: STATISTICAL ANALYSIS OF A 6 WEEK NOISE SURVEY OF 1 HOURLY PERIODS IN A RURAL FRINGE LOCATION



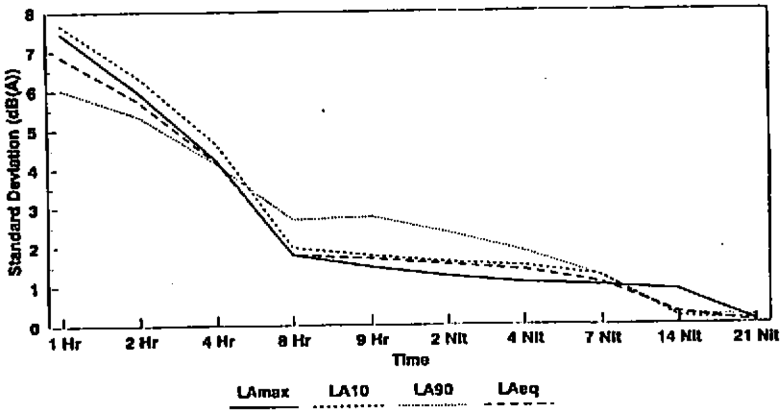
Source levels-dB(A), 1st Floor Facade

FIGURE 2: STATISTICAL ANALYSIS OF A 6 WEEK NOISE SURVEY OF 1 HOURLY PERIODS IN A RURAL FRINGE LOCATION



Source levels-dB(A), 1st Floor Facade

FIGURE 3: STATISTICAL ANALYSIS OF A 6 WEEK NOISE SURVEY OF 1 HOURLY PERIODS IN A RURAL FRINGE LOCATION



Source levels-dB(A), 1st Floor Facade

5. DISCUSSION

The variations provided by this study were then related to the L_{A10}, L_{Aeq} and L_{A90} noise indices as advocated for use in various methods of assessment. The L_{A10} noise level is used extensively for road traffic noise where measurements over the 18 hour period from 06:00 to 24:00 hours are necessary. It was found that the evening weekday L_{A10} noise levels exhibited a high standard deviation which may significantly affect the 18 hour average and should therefore be regarded with caution. The L_{Aeq} scale is becoming increasingly advocated for all forms of noise assessment and is currently used for the assessment of noise from industry, aircraft, railways, quarrying and construction and recreation/entertainment. Of these, the assessment of impact from railways is dependent upon the increase in the 24-hour L_{Aeq} above the baseline level. It has been found that a ± 3 dB(A) variation of this period and scale can occur indicating that care should be taken when undertaking such surveys. The other sources of noise, although advocating the L_{Aeq} scale for assessment, do not require finite baseline noise surveys. Finally, the L_{A90} noise index was assessed and found to be highly variable especially during evening periods. As this index is extensively used for the assessment of disturbance under BS4142 considerable care should be taken to ensure that background noise level measurement reflect an average for the area.

6. CONCLUSIONS

The noise survey was undertaken over one 6-week period at one urban fringe site in the south east of England. It is not known whether the findings of this assessment would be applicable to any survey in any location and it is considered that further work should be undertaken to determine whether these conclusions are universal or local. It is however apparent that any measurement of any time period, at any time and with any index/scale will be subject to a variability which, dependent upon the type of assessment, may alter the considered impact or effect. Future noise surveys should always be considered in the light of this variability and measures should always be taken to either minimise or at least recognise that any measurement will not necessary reflect a long term average.

7. REFERENCES

1. British Standards Institution. Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas : BS 4142 : 1990.

2. Department of Transport, Manual of Environmental Appraisal, 1983.

3. Environmental Planning and Appraisal Policy and Procedures (Issue 2), Rail Link Project, 1990.

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