PEAK NOISE EVENTS OCCURRING IN ROAD TRAFFIC NOISE

Stephen E. Samuels (1) and Jeffrey Parnell (2)

(1) Principal, TEF Consulting and Visiting Research Fellow, UNSW, Australia
(2) Manager, Environmental Monitoring, RTA NSW, Australia

Abstract

The L_{eq} descriptor measured over various day and night periods is being favoured domestically and internationally for establishment of road traffic noise criteria. These criteria are generally based on annoyance levels for a proportion of the affected community. A number of studies have, however, concluded that the use of the L_{eq} descriptor does not provide an adequate measure of sleep disturbance, therefore, road and traffic agencies are finding it increasingly important to assess the impacts of peak noise level events that may occur because of a proposed road or traffic facility. Quantification of L_{max} events is far from simple because there is always just one L_{max} event for each time interval measured and it is difficult to confirm that the cause of an identified L_{max} result was a road traffic incident, rather than say a dog barking. The present paper deals with a study of the peak noise level events that were observed in road traffic in the NSW cities of Newcastle and Wollongong, particularly during the night time. Over all days of the study it was found that road traffic noise was the dominant noise source at selected noise sensitive sites for 55% of the time. For the remaining periods, sources other than road traffic represented the dominant influences on the noise climate at each of the sites. Aggregated over all sites in both cities it was concluded that the L_{max} exceeded the L_{eq} by 15 dB(A) or more for 35% of the time between 10 pm and 6 am as a direct result of road traffic.

Introduction

The L_{eq} descriptor measured over various day and night periods is being favoured domestically and internationally for establishment of road traffic noise criteria. These criteria are generally based annoyance levels for a proportion of the affected community. A number of studies have, however, concluded that the use of the L_{eq} descriptor does not provide an adequate measure of sleep disturbance [1]. While there is no consensus on the most appropriate way to assess sleep disturbance, it is generally accepted that it is the number, and the emergence of these events where the noise level reaches a peak (defined as a "peak noise level event" in this study), that tend to result in sleep disturbance.

Because of complaints regarding sleep disturbance, road and traffic agencies are therefore finding that it is becoming increasingly important to assess the impacts of peak noise level events that may occur because of a proposed road or traffic facility. Quantification of L_{max} events is difficult because there is always just one L_{max} event for each time interval measured and confirming that the cause of an identified L_{max} result was a road traffic incident, rather than say a dog barking can also be difficult without attended monitoring. Previous NSW guidelines such as SPCC (1982) [2] suggested that the readily measured descriptor L_1 should not be 15 dB greater than the L_{90}. This criterion was able to take into account "emergence" but did not, however, directly address the L_{max} peak nor the number of events. In pursuing this issue of peak noise events generated by road traffic further, the present paper deals with a study of the peak noise level events that were generated by road traffic in the NSW cities of Newcastle and Wollongong, particularly during the night time.

Data Collection and Analysis

Data collection

As indicated previously, the work reported in this paper was aimed at determining the incidence of, and the extent to which the L_{max} sound level exceeded the L_{eq} by more than 15 dB(A), between the hours of 10 pm and 6 am for representative noise sensitive localities in Newcastle and Wollongong. To do this, traffic noise levels, classified traffic counts and other relevant data were measured simultaneously at two representative locations in Newcastle and at two representative locations in Wollongong. Monitoring locations were chosen to allow representative data to be collected from the target road. In all cases the target was a straight section of two lane divided carriageway and was not in close proximity to any traffic control devices or intersections. The Newcastle sites were between 3 and 5% vertical grade, whilst the Wollongong sites were essentially flat. The four sites were at residences situated at the following locations:

Newcastle:	Wyong Road, Tumbi Umbi (70 km/h)
	Elizabeth Street, Mayfield (80 km/h)
Wollongong:	Albert Street, adjacent to the Northern Distributor (80 km/h)
	Jones Place, adjacent to the Northern Distributor (80 km/h)

In concert with routine practice [3] the noise levels were monitored 1m in front of the most exposed façade of the residence at each monitoring location using calibrated, precision instrumentation. Weather conditions were fine and mild throughout all measurements.

The data were continuously recorded over 5 and 6 days at the Wollongong Sites and over 7 days at the two Newcastle Sites. Moreover, the measured noise levels were sampled every 15 minutes each hour of the day, which produced 96 samples per day at all sites. Within each 15-minute sample 8 noise indices were determined and recorded, however for the present paper, just the L_{max}, L_{10} and L_{eq} are examined. Since these data were actually collected three years ago the sites were revisited recently and it was observed that the traffic and general site conditions had remained essentially the same as they were during the data collection periods.

Data analyses

Prior to commencing the peak noise event analysis, the measured noise data from each of the four sites were subjected to a screening process to identify the noise data samples for which road traffic was the dominant source. The potential influences of any other noise sources that could be present had to be identified for the analysis to be valid. Such influences could occur within any of the 15-minute sample periods from which the data for the present analysis were sourced. Because of the largely random and short-term nature of these influences, they could potentially affect either the L_{max} or the L_{eq} or, indeed, both indices. Data screening was therefore undertaken by application of Equation 1, which is a well known and robust relationship that applies exclusively to traffic noise data and not to noise data resulting from other sources [4].

$$L_{10}(1\ \text{h}) = L_{eq}(1\ \text{h}) + 3 \qquad (1)$$

Each of the 15-minute samples of noise data collected at the four sites between the hours of 10 pm and 6 am was checked for reasonable compliance with this relationship. The compliance criterion adopted was a range of +/- 1 on Eqn 1. That is, road traffic was determined to be the dominant noise source if the data complied with the relationship when the constant was anywhere between 2 and 4. This compliance criterion was adopted on the basis of the acceptance that the relationship of Eqn 1 becomes less robust at extremely low traffic flow rates. However a fundamental objective of the present study was to investigate peak traffic noise events, not to investigate peak noise events from other sources. Hence a data screening process was mandatory prior to undertaking the analysis. The additional justification for adoption of this particular procedure was the widely accepted premise [5] that each 15 minute sample provides sufficient data from which a scientifically and statistically acceptable estimate of the one hour road traffic noise indices, which appear in Eqn 1, may be determined.

As a consequence of the data screening process for the Newcastle data it was found that in 211 of the original 448 samples (47%) road traffic was the dominant noise source. The comparable figure for the Wollongong data was 222 of the original 352 (63%). These proportions of 47% and 63% reflect the comments made earlier in this paper concerning the difficulties in collecting the good quality traffic noise data required to investigate and assess peak noise events. From there, the data were analysed by means of relatively straightforward spreadsheet techniques. Simply, the data for which road traffic was the dominant noise source were examined to determine the incidences of L_{max} exceeding L_{eq} by 15 dB(A) or more.

RESULTS

Exceedences of L_{max} over L_{eq} from 10 pm to 6 am

In Figure 1, data typical of that ensuing from the analysis are shown for one of the Wollongong sites. This graph indicates the proportion of samples in each hour when the L_{max} did and did not exceed the L_{eq} for those samples included where road traffic was the dominant noise source. Overall the L_{max} exceeded the L_{eq} by 15 dB(A) or more during 60% of the samples included in Fig 1. When these data were aggregated by city it was found that this particular exceedence occurred in 84% of the Newcastle samples and 54% of the Wollongong samples included in the analysis. Prior to exploring and interpreting these findings further, it is necessary to put them in an appropriate context.

To do this, the analysis was extended to produce the resulting outcomes presented in Table I, which may now be explained in some detail. Firstly, the figures in the column entitled “Samples included in analysis (%)” show the samples included in the analysis where road traffic was the dominant noise source as percentages of the total number of samples. The next column in Table I shows the exceedences for the samples included in the analysis when road traffic was the dominant noise source. The final column lists the exceedences as percentages of all samples. For example, at the Wyong Road Site in Newcastle, road traffic was the dominant noise source for 36% of the samples collected over the 7 nights of data collection. For 96% of these particular samples, the L_{max} exceeded the L_{eq} by 15 dB(A) or more, however, the L_{max} exceeded the L_{eq} by 15 dB(A) or more for only 34% of all the samples collected at this Site. When aggregated over the four sites in both cities, the L_{max} exceeded the L_{eq} by 15 dB(A) or more during 69% of samples when road traffic was the dominant noise source and for 35% of all samples.

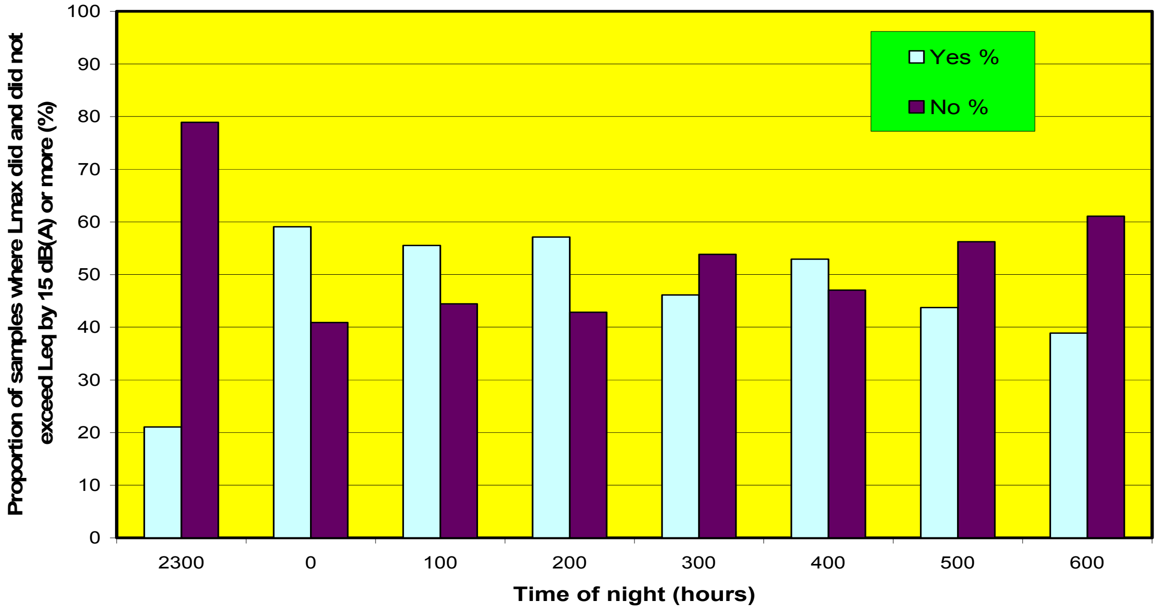

Figure 1. When L_{max} did and did not exceed L_{eq} by 15 dB(A) or more each hour for those samples included in the analysis at the Albert Street Site in Wollongong where road traffic was the dominant noise source.

Discussion

The noise sources

As shown in the first column of Table I, road traffic was the dominant noise source from 36% to 71% of the samples collected at each site. Overall, road traffic was the dominant noise source for 55% of all samples collected at the four sites between 10 pm and 6 am over a total of 25 evenings. For the remaining periods, sources other than road traffic were the dominant influence on the noise climate at each of the sites. Identification of these other sources was not possible through further analyses of the existing data, nor was it included in the scope of the present study. What may be reasonably speculated is that they arise from the usual array of sources that operate in suburban areas such as those in which the four sites are located. Typically these sources include air conditioning systems, nearby plant or equipment and neighbourhood activities such as the use of televisions or stereo systems. Irrespective of the nature of these sources, an important outcome of the present study is the finding that while road traffic was a major contributor to the night time noise climate at the sites studied, there were substantial periods of time when the climate was dominated by sources other than road traffic.

Exceedences of L_{max} over L_{eq} by 15 dB(A) or more

The exceedences of L_{max} over L_{eq} by 15 dB(A) or more during those specific times when road traffic was the dominant noise source during the 10 pm to 6 am period are set out in the fourth column of Table I. On those occasions the L_{max} exceeded the L_{eq} by 15 dB(A) or more for 84% of these times at the Newcastle sites and for 54% of these times at the Wollongong sites. Aggregated over all four sites this particular exceedence occurred for 69% of these specific times between 10 pm and 6 am. A precise explanation of why these exceedences occurred would require an additional research investigation focused on the nature of the traffic noise at each site and how this nature varied in response to factors such as traffic flow, speed and composition. Again, so doing was outside the scope of the present study.

As explained previously, the final column of Table I presents the incidences of the L_{max} arising from road traffic exceeding the Leq by 15 dB(A) or more in relation to all the data samples collected from 10 pm to 6 am at all four sites. The total set of samples includes those periods when road traffic was the dominant source plus those when other sources dominated. Over this total set of samples, L_{max} arising from road traffic exceeded L_{eq} by 15 dB(A) or more for 38% of the time at the Newcastle sites and for 33% of the time at the Wollongong sites. Aggregated over all four sites this particular exceedence occurred for 35% of the time period between 10 pm and 6 am. In other words, the overall outcome was that the L_{max} exceeded the L_{eq} by 15 dB(A) or more for 35% of the time between 10 pm and 6 am at all sites in both cities as a direct result of road traffic.

What must be noted in relation to this outcome is that, as explained in detail previously, the analysis utilised data that had been collected in 15-minute sample periods. That is, the analysis was directed at an investigation of the extent to which the peak level of traffic noise exceeded the L_{eq}. Consequently it has not yet been

Table I. Detailed interpretation of exceedences

City	Location	Samples for which road traffic was the dominant noise source (%)	L_{max}>L_{eq} +15 for samples where road traffic was the dominant noise source (%)	L_{max}>L_{eq} +15 for all samples (%)
Newcastle	Wyong Road	36	96	34
	Elizabeth Street	58	72	42
	All Newcastle	47	84	38
Wollongong	Albert Street	53	60	32
	Jones Place	71	47	33
	All Wollongong	63	54	33
All Sites		**55**	**69**	**35**

possible to investigate the maximum noise events associated with the passage of individual (noisy) vehicles. Such an investigation would require a similar study to that reported herein, but in which individual vehicle passby noise and associated data were collected during the 10 pm to 6 am period. An investigation of this type, which was well beyond the scope of the present study, could be a fruitful area of future research.

CONCLUSIONS

As a consequence of all that appears herein, the following key conclusions have been drawn:

- During the 10 pm to 6 am period over all the measurement days at the four sites, road traffic noise was the dominant noise source from 36% to 71% of the time. Overall, it was concluded that road traffic was the dominant source for 55% of the time. For the remaining periods, sources other than road traffic represented the dominant influences on the noise climate at each of the sites.

- During those specific times when road traffic was the dominant noise source within the 10 pm to 6 am period, it was concluded that the L_{max} exceeded the Leq by 15 dB(A) or more for 84% of those times at the Newcastle sites and for 54% of the times at the Wollongong sites. When aggregated over all four sites, it was further concluded that this particular exceedence occurred for 69% of those specific times between 10 pm and 6 am when road traffic was the dominant noise source.

- A somewhat different result ensued over the complete set of data samples measured between 10 pm to 6 am at all sites. This complete data set included those times when road traffic was the dominant source plus those times when other sources dominated. For this complete set, it was found that the L_{max} exceeded the L_{eq} by 15 dB(A) or more for 38% of the time at the Newcastle sites and for 33% of the time at the Wollongong sites. Aggregated over all four sites this particular exceedence occurred for 35% of the time period between 10 pm and 6 am. Thus it was concluded that the L_{max} exceeded the L_{eq} by 15 dB(A) or more for 35% of the time between 10 pm and 6 am as a direct result of road traffic.

- The lack of correlation between road traffic noise and L_{max} needs to be recognised by regulators and road authorities seeking to quantify sleep disturbance based on peak noise level events generated by road traffic.

- Selection of monitoring location is extremely important as it can significantly impact upon the contribution of extraneous peak noise events.

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