ICSV14

Cairns • Australia

9-12 July, 2007

14th International Congress on Sound & Vibration

CORRELATION OF RURAL HIGHWAY ROAD TRAFFIC NOISE WITH VEHICLE SPEED AND COMMERCIAL VEHICLE PERCENTAGES FOR THE DAY AND NIGHT TIME PERIODS.

Matthew Stead[1], Darren Jurevicius[1] and Philip Agnew[2]

[1]Bassett Acoustics
Level 6, 100 Pirie Street, Adelaide, SA 5000, Australia
acoustics@bassett.com.au
[2]Department Transport, Energy and Infrastructure
33-37 Warwick Street, Walkerville, SA 5081, Australia
philip.agnew@saugov.sa.gov.au

Abstract

Road traffic noise and associated noise model predictions for rural highways are heavily influenced by the speed and number of commercial vehicles. It is in the public's interest to improve the accuracy of noise models to enable accurate representation of traffic noise impacts and design of appropriate noise mitigation treatment. A study has been carried out to measure road traffic noise simultaneously with traffic counts using commercially available noise and traffic count loggers. The correlation between traffic noise, vehicle type, variations between day and night and the effects of speed have been assessed at a rural location in South Australia. The correlations are presented for the purpose of gaining a better understanding of vehicle class noise emission values with respect to recognised noise models prediction for rural highways.

1. INTRODUCTION

A traffic counter and noise logger were located along the Sturt Highway, North of Gawler, South Australia, Australia. Noise and traffic data were recorded between 7th March 2007 and 22nd March 2007. The traffic data was recorded on a Microcom v316 traffic logger. The noise data was recorded on an Aclan 01dB Class 1 noise logger.

The location for the data collection was chosen as it represented a permanent traffic logging site. The road has one lane of traffic in each direction and minimal gradient. There as minimal gradient and no barriers between the road and the microphone location. There are some trees and some ground foliage between the road and the logging location. These are not considered to have significantly affected the results.

The noise logger was located 75 m from the edge of the road. The distance to the nearby traffic was an additional 1.75 m (half lane width) and 5.25 m for the far side traffic. The road at the test site has a posted speed of 100 km/hr. The road surface consists of a 7mm spray seal. The seal is approximately 7 years old with an existing annual average daily traffic count of 10,000 vehicles comprising of 15% commercial vehicles (source Department of Transport

Energy and Infrastructure). Fleming et al [1] used a 15 m setback for the establishment of reference energy mean emission levels for different vehicle types as a basis for the FHWA Traffic Noise Model. The setback distance chosen for this study represents a typical rural residential location and allows investigation of the noise emission level variances at this distance. Appropriate separation distances were applied to the traffic data to ensure individual vehicle events where isolated and analysed within the constraints of the noise logger type and functionality.

2. RESULTS

2.1 Data Processing

The results of the traffic and noise logging were stored in electronic data files for post processing. The traffic logger recorded a variety of data for each vehicle passing including the date and time of the event, direction, vehicle speed and Austroads class of vehicle (refer Figure 1). The noise logger recorded equivalent noise levels (L_{eq}) every 2 seconds with the overall dB(A) level being stored with the associated spectrum in octave bands (31.5 Hz to 16 kHz).

The initial data processing involved isolating individual traffic events such that there was at least 10 seconds clear both before and after each valid vehicle data point. The maximum noise level was then identified in the period and a check was made to ensure that there was a clear peak associated with the passing vehicle.

The wind speed and direction was also obtained for the period to assess any impact on the results. The wind speed was sourced from the Roseworthy Bureau of Meteorology site 023122. The Roseworthy site is approximately four kilometres from the traffic logging site with a similar topography. Data points where the wind speed exceeded 5 metres per second were excluded. The effect of wind speed was analysed by isolating wind conditions at or below 5 metres per second.

The data analysis resulted in 5092 data points representing the noise associated with individual motor vehicles where the speed, class, wind speed and direction are known. The source emission level was calculated based on the tangential distance to the motor vehicle and assuming hemispherical spreading.

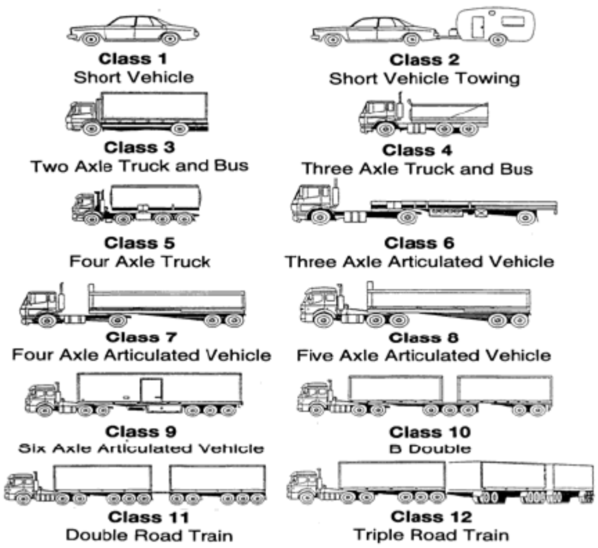

Figure 1. Austroads Vehicle Classifications

2.2 Source Emission Level and Vehicle Classification

The data was analysed to determine regression curves associated with the source emission level, vehicle speed and class. There was insufficient data for some of the vehicle classes to enable a satisfactory representation of the relationship between vehicle speed and source emission level. The following table summarises the data recorded for each of the vehicle classes.

Table 1. Summary of measured data by vehicle class.

Class	Sample Size	Sample Size (%)	Speed (km/hr)		Lw A Max dB(A)		Correction to Class 1 dB(A)	Source Emission Regression Equation x = speed, Lw A max
			Median	SD	Median	SD		
Overall	5092	100%	95.9	10.1	109.2	4.6	2.1	1.5255Ln(x) + 102.41
1	3454	68%	97.7	10.0	107.1	4.1	0.0	5.8231Ln(x) + 81.09
2	159	3%	89.3	11.1	108.1	3.7	1.0	5.4107Ln(x) + 84.18
3	92	2%	88.4	10.9	108.8	3.7	1.7	1.6562Ln(x) + 101.65
4	56	1%	90.0	8.2	109.6	2.9	2.5	13.472Ln(x) + 49.074
5	9	0%	89.9	13.7	110.6	3.1	3.5	-7.8792Ln(x) + 146.68
6	6	0%	90.5	10.7	110.3	2.7	3.2	2.6054Ln(x) + 100
7	23	0%	80.4	12.6	108.1	3.2	1.0	7.8351Ln(x) + 74.122
8	60	1%	91.1	7.8	111.7	2.3	4.6	2.5677Ln(x) + 100.76
9	501	10%	92.5	8.1	113.1	2.3	6.0	7.6501Ln(x) + 78.666
10	712	14%	93.6	9.1	114.5	2.2	7.4	8.6745Ln(x) + 75.414
11	14	0%	93.7	6.5	113.1	2.8	6.1	-6.3977Ln(x) + 142.63
12	6	0%	81.0	8.0	115.5	2.6	8.4	17.173Ln(x) + 39.272

Note:

1. Lw A Max = Maximum source emission level (dB(A) re 10 -12 W) calculated assuming hemispherical spreading and no significant ground absorption.

2.3 Comparison with CORTN and TNM Speed Regression

The Calculation of Road Traffic Noise (CORTN) is one of the methods used in Australia for the prediction of road traffic noise. The Federal Highway Administration (FHWA) Traffic Noise Model (TNM) is the method used by the U.S. Department of Transportation for the prediction of road traffic noise and is also used in Australia. The CORTN and TNM methods were compared with the measured results presented in the previous section.

A comparison of the CORTN, TNM and measured vehicle emission regression curves are presented in Figures 2 and 3. All of the data was normalised to 75 km/hr and 100 % cars giving a 0 dB(A) correction. This is consistent with the method used in CORTN. The results presented in Figure 2 show the standard CORTN corrections, TNM corrections and the measured vehicle emission levels of this investigation. Figure 3 shows the calculated corrections utilising the percentage of commercial vehicles measured on the Sturt Highway.

Figure 4 shows the regression curve for cars (Class 1) during the day and night time periods and an average of the day and night data. There is approximately ± 1 dB(A) variation between the 24hr regression curve compared to the day and night data for this site. There is insufficient data to establish a causal relation for the lower received noise levels at night time and during the daytime for commercial vehicles.

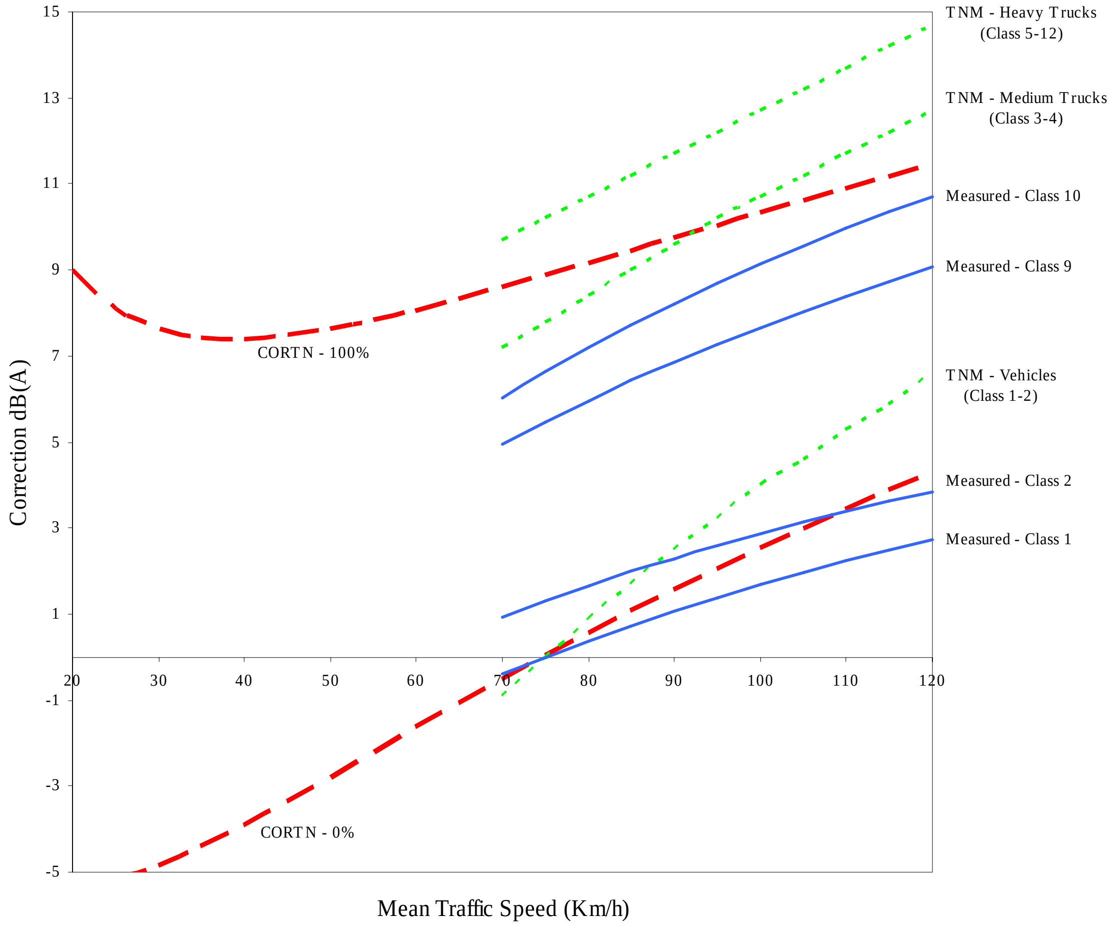

Figure 2. CORTN and TNM corrections versus measured data for mean traffic speed by vehicle class.

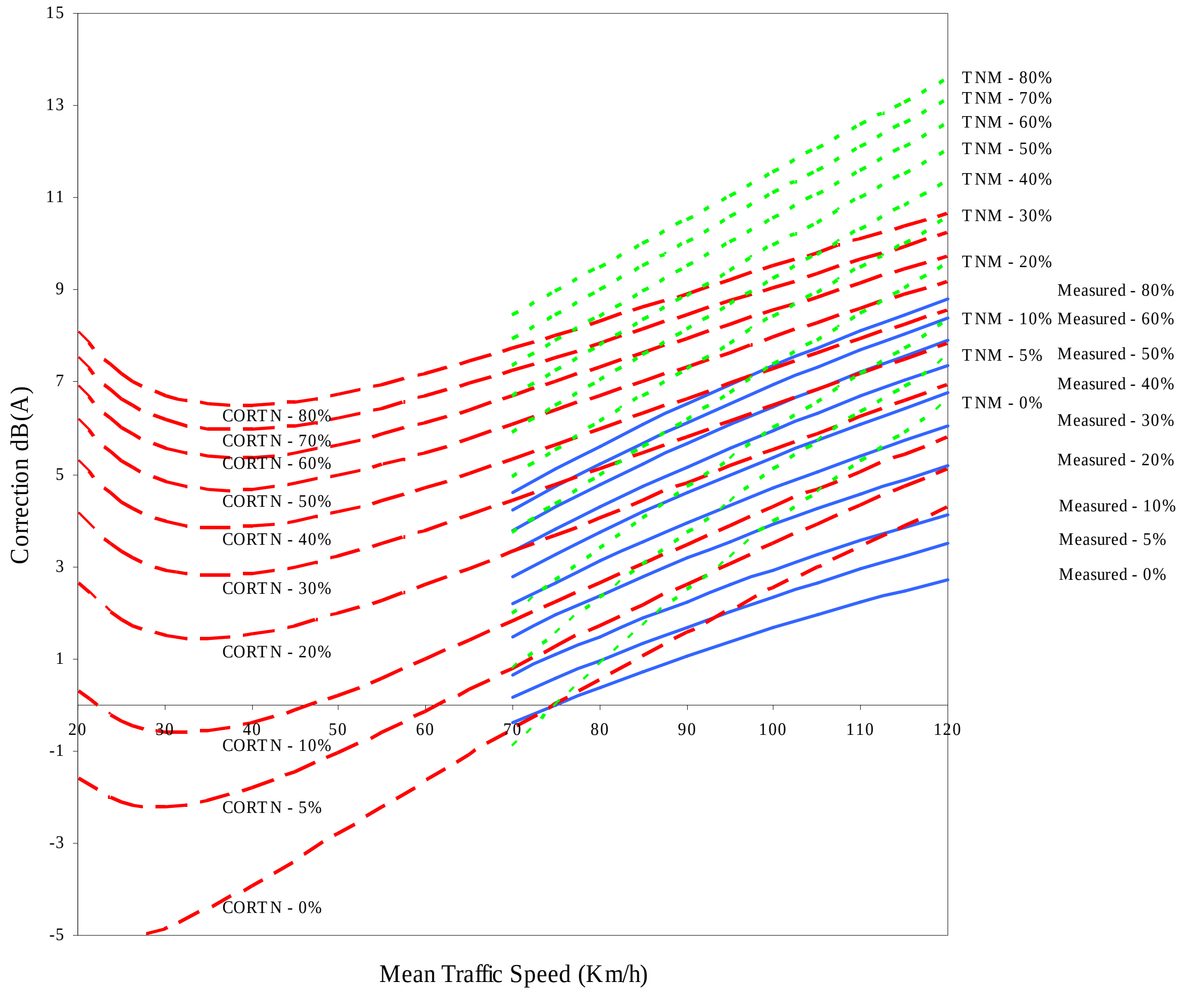

Figure 3. CORTN and TNM correction versus measured data for mean traffic speed by percentage commercial (heavy) vehicles.

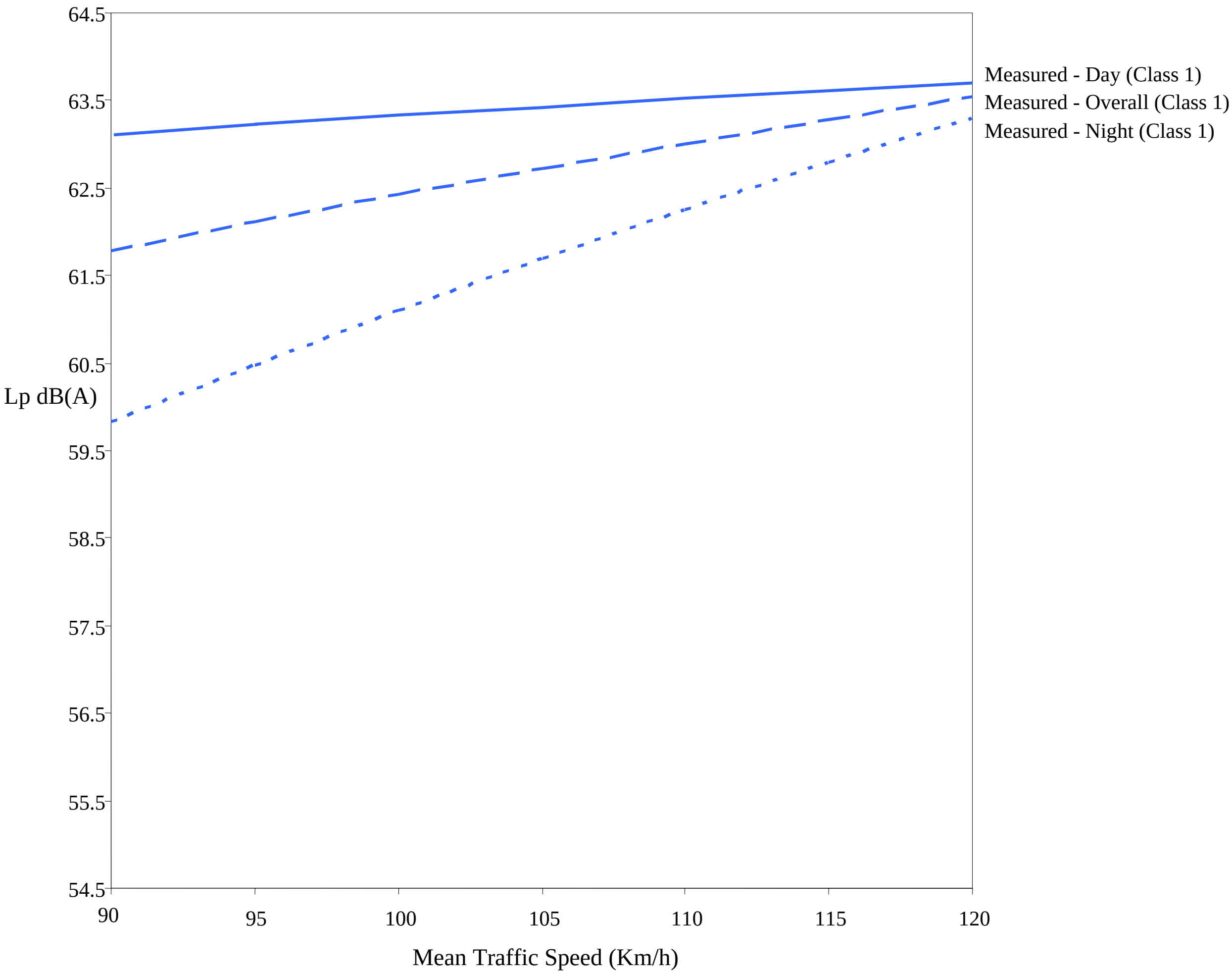

Figure 4. Received noise level for Class 1 vehicles versus mean traffic speed for the day and night period and the day and night average.

2.4 Wind Effects

The influence of the wind direction on the received noise level for Class 1 vehicles was analysed. Insufficient data was available for commercial vehicle classifications to be included in this analysis. The direction of the road was taken as 25º from North. The wind direction was then separated into quadrants based on the road direction with the effects of wind direction, towards the microphone, away from the microphone and parallel with the road, then analysed for comparison with the overall data. The difference noted between the higher and lower received noise levels was 3 dB(A). The effect of wind direction on the received noise level from cars is inconclusive. A further study could be carried out to determine the effects of wind direction on the measured noise levels, obtaining a larger data set and focussing on some of the vehicle classifications that have been identified with lower standard deviations. The difference between day and night received noise levels also requires further investigation into meteorological effects such as wind direction, atmospheric stability class and temperature variations.

3. CONCLUSIONS

The measurements and resulting regression curves for cars and commercial vehicles in Australia when compared to the CORTN and TNM equivalent curves show reasonable agreement (± 1dB(A)) in the 75 to 100 km/hr range for cars. Car noise does not increase as much as CORTN and TNM when speed increases i.e. the regression curve slope is not as steep. Note that regression curves have been normalised to 75 km/hr and 0 % commercial vehicles.

A more significant difference is noted between commercial vehicles and the cars. The measured levels were lower than CORTN by 2 to 3 dB(A) and lower than TNM by 3 to 4 dB(A). There are a number of variables that require further investigation to adequately understand this result, such as the effect of intervening topography and meteorology on the received noise level at 75m as well as an improved statistical data set.

The relationship between mean traffic speed and correction by vehicle class shows a greater correlation between the measured data and CORTN for cars (Class 1 and 2 vehicles) than the TNM model. The opposite relationship is observed for commercial vehicles where a greater correlation is observed between measured data and the TNM model.

The received noise levels for Class 1 vehicles were lower during the night time period. The night time relationship showed a more positive gradient with respect to vehicle speed than the daytime measurements. This noted phenomenon is inconsistent with common understanding and experience where the received noise level is likely to increase during the night time period, with respect to individual vehicle drivebys, due to lower road surface temperatures. Further investigation is required to account for these differences.

This study has demonstrated that standard noise and traffic logging equipment may be used to gather reasonable data for validating CORTN and TNM models for Rural Highways in Australia. However it appears that the received noise level, at typical rural locations and within the bounds of some standard modelling parameters and assumptions:

- <5m/s wind speed
- no adjustment for temperature changes

is influenced by these parameters. Given the apparent sensitivity to weather conditions and other parameters future studies should utilise more rigorous statistical analysis and data collection to reduce the level of potential error.

Nevertheless, the limited data set in this study has provided useful insight into the noise emissions from commercial vehicles as well as the practical issues of calibrating recognised prediction models at the chosen logging distance from the road. The work presented is considered ‘in progress’ with the future aim of developing a better understanding of vehicle class source emissions levels and prediction of traffic noise for Australian rural highways and the current vehicle fleet.

REFERENCES

[1] Fleming G, Rapoza JA. “Development of National Reference Energy Mean Emission Levels for FHWA Traffic Noise Model Version 1.0”, Report FHWA-PD-96-008 and DOT-VNTSC-FHWA-96-2, FHWA, US Department of Transport, 1996.

[2] United Kingdom, Department of Environment/Transport (UKDOE), Welsh Office HMSO, “Calculation of Road Traffic Noise”, manual published 1988 (updated from 1975 publication).