Applied Acoustics 70 (2009) 284–296

Contents lists available at ScienceDirect

Applied Acoustics

journal homepage: www.elsevier.com/locate/apacoust

# Assessing methodologies for calculating road traffic noise levels in Ireland – Converting CRTN indicators to the EU indicators ($L_{den}$, $L_{night}$)

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ARTICLE INFO

*Article history:*
Received 2 January 2008
Received in revised form 26 March 2008
Accepted 2 April 2008
Available online 27 May 2008

*Keywords:*
Road traffic noise
CRTN
Conversion procedures
$L_{den}$
Noise mapping

ABSTRACT

To comply with the EU Noise Directive 2002/49/EC, Member States are required to produce strategic noise maps for designated areas, including mapping road traffic noise from major roads. These maps must be presented using the EU indicators $L_{den}$ and $L_{night}$. However, the most common noise indicator used in Ireland at present is the $L_{A10,18h}$ indicator arising from the use of the Calculation of Road Traffic Noise (CRTN) prediction method. Therefore, a relationship needs to be established between $L_{A10,18h}$ and $L_{den}$ and $L_{night}$, separately. In addition to noise mapping these indicators are used for noise abatement purposes, so the proposed relationship must be accurate and robust. In 2002, the UK's Transport Research Laboratory (TRL) published a paper describing mathematical procedures that could be used to convert values of $L_{A10}$ to $L_{den}$ and $L_{night}$. These procedures were then adopted for use in Ireland. This paper examines the suitability of the TRL conversion methods 1 and 3 for use under Irish road conditions. Method 2 was not considered in this study, as it was a methodology not applicable in an Irish scenario. Studies concluded that where hourly traffic data are available, the conversion methodology outlined in TRL Method 1 is robust and reproducible. However, in the absence of hourly traffic data where daily traffic counts are used, the relevant conversion procedures produce variable results for both $L_{den}$ and $L_{night}$ when applied to Irish road conditions. To reduce the variability, new conversion procedures were developed, specifically for Irish road conditions.



## 1. Introduction

Environmental noise is increasingly becoming a concern to European Union (EU) citizens and is now the focus of EU and national legislation. The EU Directive (2002/49/EC) relating to the assessment and management of environmental noise was published in 2002 and it aims to create a quieter and more pleasant environment for European citizens within the framework of "Sustainable Development and Growth in Europe" [1]. It deals mainly with the definition of universal noise indicators, strategic noise mapping, noise management action plans and prediction methodologies. The Directive was transposed into Irish law in April, 2006, through Statutory Instrument No. 140 of 2006 [2].

In response to the adoption of the EU Directive, the Irish National Roads Authority (NRA) reviewed its approach to the design of national roads schemes with regard to noise criteria. Prior to this review most schemes were designed to meet a de facto standard (that has not been enshrined in any form of policy document or given legal effect) of 68 dB(A) $L_{A10,18h}$ based on guidance from the United Kingdom (UK). The $L_{A10,18h}$ indicator is the arithmetic average of the 18 one hour $L_{A10,1h}$ values (i.e. the noise level exceeded for 10% of the hourly period) from 06:00 to midnight and is used in the UK for the purpose of their Insulation Regulations and it contains a correction factor of +2.5 dB for the reflection from a façade. This façade correction factor is not incorporated in the designated noise indicators defined in the EU Directive where a "free field" sound level is specified.

Arising from the review, the Authority published guidelines for the treatment of noise and vibration in the planning and development of national roads schemes [3]. The guidelines contained non-statutory design goals with the objective to achieve appropriate consistency in respect to the treatment of noise and vibration during the planning, construction and operation phases of the road scheme. In addition to these design goals, the guidelines also encompassed the procedures for the conversion of the CRTN indices to the designated EU indicators as developed by the Transport Research Laboratory (TRL), in the UK.

Currently, the calculation of road traffic noise in Ireland is undertaken using the, UK's "Calculation of Road Traffic Noise" (CRTN) method and is the most widely used method in Ireland today [4]. It is preferred over the EU recommended interim method,

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doi:10.1016/j.apacoust.2008.04.003

the French national standard, NMPB-Routes-96, due to a number of shortcomings previously identified in a study undertaken by TRL [5]. These shortcomings, as they pertain to Ireland, may be summarised as follows [3]:

1. Software packages currently used for modelling in accordance with CRTN cannot be adapted to NMPB-Routes-96. New packages or calculation modules would be required.
2. Meteorological information required for the purposes of establishing long-term noise values is not readily available for the whole of Ireland.
3. The standard error in prediction is not known.
4. The method has not been used previously in Ireland.

CRTN allows the user to calculate values of $L_{A10,1h}$ or $L_{A10,18h}$ depending on whether the available traffic parameters relate to a single hour or to the specified 18-hour period. The $L_{den}$ index as defined by the 2006 Regulations refers to values of $L_{Aeq}$ averaged over the day, evening and night periods, comprised of 12, 8 and 4 hours, respectively. $L_{night}$ is calculated in a similar manner over the night period and is used as a noise indicator for sleep disturbance. By developing a procedure for converting the $L_{A10}$ indicator to $L_{den}$ and $L_{night}$, it means that users will not have to change existing models of software for the prediction of EU noise indices.

The introduction of the new EU indices had a significant impact on the designated design goals. The design goals for noise were necessary to ensure that the national roads programme proceeded on a path of sustainable development. The initial draft of the NRA guidelines set design goals of 60 dB $L_{den}$ and 50 dB $L_{night}$. Initial studies observed greater inconsistencies between measured and calculated results for the $L_{night}$ conversions than the $L_{den}$ conversions, which were particularly evident at noise levels below 60 dB(A) $L_{A10,18h}$. This variance had the potential to result in some degree of uncertainty in performing a robust assessment of the $L_{night}$ and $L_{den}$ criteria.

Accordingly, the Authority undertook a series of detailed validation studies based on the experience acquired from the implementation of the new draft guidelines. The studies focused on a comparison of actual measured $L_{den}$ and $L_{night}$ values from 70 national roadside locations with calculated $L_{den}$ and $L_{night}$ values using the conversion procedures set out by TRL in methods 1 and 3. It should be noted that 25 of the 70 selected sites were identified as being influenced by motorway traffic. The study also compared measured $L_{A10,18h}$ values with measured and calculated $L_{den}$ and $L_{night}$ values.

The primary objectives of the validation studies were:

- to assess the applicability of the specified design goals and ascertain how measured $L_{den}$ and $L_{night}$ values compared to the measured $L_{A10,18h}$ noise levels
- to assess the functionality of TRL's conversion methodologies (Methods 1 and 3) for deriving $L_{den}$ and $L_{night}$ values under Irish conditions

It should be noted that the primary purpose of this study was to examine the methods of converting CRTN indices to the relevant EU noise indices for the purposes of road planning and the setting of appropriate design goals, as CRTN is implemented universally in Ireland. Conversions are compared directly with measurements and as such no direct comparisons can be made with predictions from the recommended interim method, NMPB-Routes-96 [6].

### 1.1. Measurement campaign

Hourly noise indicators measured over 24-hour periods at 70 sample sites in close proximity to national road schemes were analysed in the study. All measurements were unattended and were carried out in accordance with the measurement procedures as described in CRTN. Although $L_{den}$ is a yearlong indicator, for the purpose of this study it was assumed that a 24-hour period would be representative of the yearlong level. In this manner comparisons could be made between $L_{den}$ and $L_{A10,18h}$ from measurements recorded on site. The parameters measured at these sites were as follows:

- $L_{A10}$
- $L_{A90}$
- $L_{A01}$
- $L_{Aeq}$

All measurements were converted to free field values and the $L_{den}$ indicator was calculated from the $L_{Aeq,1h}$ values according to

$$L_{den} = 10\lg\left(\frac{1}{24}\right)\left(12.10^{\frac{L_{day}}{10}} + 4.10^{\frac{L_{evening}+5}{10}} + 8.10^{\frac{L_{night}+10}{10}}\right) \quad (1)$$

where $L_{day}$ represents the A-weighted equivalent sound level of the day period, between the hours of 07:00 and 19:00, $L_{evening}$ represents the A-weighted equivalent sound level of the evening period, between the hours of 19:00 and 23:00 and $L_{night}$ represents the A-weighted equivalent sound level of the night period, between the hours of 23:00 and 07:00 [1]. This calculated value for $L_{den}$ was the reference value that was used as a benchmark to evaluate the various conversion methods outlined below. It is hereafter referred to as the *measured* $L_{den}$.

In general, most of the sample sites were located in close proximity to vehicular traffic where noise levels were greater than 60 dB $L_{A10,18h}$ while 13 sites could be defined as background in nature where noise levels were generally less than 55 dB $L_{A10,18h}$.

## 2. Transport research laboratory method evaluation

In 2002, TRL published a paper describing a number of mathematical procedures that could be used to convert values of $L_{A10,1h}$ and $L_{A10,18h}$ to values of $L_{den}$, $L_{day}$, $L_{evening}$ and $L_{night}$. This meant that CRTN could be used to estimate the necessary EU indices by applying an end correction to the calculated values of $L_{A10}$. It should be noted that the TRL procedures were developed for the purposes of noise mapping and not specifically for setting noise criteria or limits values for use in highway design.

A separate conversion procedure is described for different available periodic traffic counts; (i) hourly traffic counts, (ii) traffic counts for the day, evening and night periods and (iii) 18-hour traffic counts. The second case may be applied when detailed hourly traffic data is not available but traffic data is known or can be estimated for the day, evening and night periods. CRTN is used to calculate $L_{A10,18h}$ which is then used to estimate values for $L_{day}$, $L_{evening}$ and $L_{night}$. As such this method, Method 2, was not considered in this study, as it was not generally applicable in an Irish scenario and as such unlikely to be used in practise due to the lack of source traffic flow data in this format.

### 2.1. Method 1

TRL's Method 1 is to be used when hourly traffic volumes are known and are used to predict $L_{A10,1h}$ levels. The $L_{A10,1h}$ index may be converted to the $L_{Aeq,1h}$ indicator using the formula:

$$L_{Aeq,1h} = 0.94 \times L_{A10,1h} + 0.77 \text{ dB} \quad (2)$$

These hourly levels may then be used to calculate the relevant periodic level $L_{day}$, $L_{evening}$ or $L_{night}$. $L_{den}$ may then be calculated from Eq. (1) above. There is a separate relationship for non-motorway roads