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"CALCULATION OF RAILWAY NOISE"

Brian Hemsworth

Acoustics Unit, British Rail Research, Derby

1. INTRODUCTION

In November 1991 in announcing the Government's response to the recommendations of the Mitchell Committee, the Secretary of State for Public Transport stated that the Department of Transport would prepare Noise Insulation Regulations for Railways and propose a procedure for calculating the noise from trains by which eligibility for insulation would be assessed.

A technical sub group comprising: Paul Nelson, Chairman, (TRL), Phil Abbott (TRL), John Sargent (BRE), Geoff Leventhall (Commins Partnership), Graham Parry (DNV Technica), John Edwards (LUL) and Brian Hemsworth (BR Research) was set up to carry out this task and the resulting draft "Calculation of Railway Noise" was issued for comment on 11 October 1993.

The aim of this paper is to give a broad summary of that document and to give the opportunity for an initial discussion on its contents.

2. STRUCTURE OF THE CALCULATION PROCEDURE

The objective was to produce a chart based procedure, similar in format to "Calculation of Road Traffic Noise" (CRTN) but capable of predicting the daytime L_{Aeq} (0600-2400) and nighttime L_{Aeq} (0000-0600) from moving trains for a railway situation typical of that operated in the UK.

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- multi-track
- freight and passenger operation
- diesel or electric haulage.
- maximum speed 250km/h

This includes operations such as those run by London Underground Ltd and PTE's.

For such railways there are potentially two major noise sources:

- vehicle rolling noise
- diesel locomotive power unit noise.

These are considered separately and the flow diagram for the calculation procedure is given in Figure 1. This indicates that, as is normal practice, L_{Aeq} is determined from a knowledge of the Sound Exposure Level (SEL) of all trains operating on the railway. It also demonstrates some of the major decisions that were taken in the development of the procedure.

- the railway is split into straight line segments having consistent source and propagation features.
- for a multi-track railway, trains on each track are treated as individual sources.
- the noise characteristics of each type of vehicle are separately identified.
- the total noise is the sum of noise from all trains on all tracks and all segments.

The major elements of the procedure are described below.

3. REFERENCE NOISE LEVELS

Base curves of SEL at a reference distance of 25m from the track as a function of train speed and normalised to a single vehicle are given in an appendix to the memorandum together with tables of correction factors for different vehicle designs. Thus within the tables, account is taken of design features which affect the noise level e.g. type of braking and the number of axles per vehicle.

The tables will be developed further as additional data on vehicle noise characteristics become available.

It has been assumed that rolling noise SEL can be taken to be proportional to 20 log(train speed) for all vehicle types, without loss of accuracy of prediction. The maximum diesel locomotive power noise is assumed to be independent of speed, hence SEL is proportional to -10 log(train speed).

The noise level for the whole train is determined by considering the number of vehicles in the train (N_v) and applying a train length correction $+ 10 \log N_v$.

At this stage corrections are made for track and track support features such as jointed track, bridges etc where these are considered necessary.

4. PROPAGATION CORRECTION TERMS

Various correction factors are applied to the reference noise level to allow for the propagation of the noise away from the railway. In developing these terms emphasis has been placed on using measured data obtained for distances within 300m of the track (the limit of the regulations) and the need for accurate prediction at close distances to the track, where the regulations are more likely to be triggered.

The following factors are considered:

- geometric attenuation
- atmospheric attenuation
- ground attenuation
- propagation over ballast
- effect of screening
- angle of view.

The values adopted have been taken from measurements, modelling rolling noise as a moving dipole source and modelling diesel locomotive power noise as a moving point source with cosine directivity. This represents a major difference between this procedure and CRTN where the modelling is based on an infinite line source. Thus although corrections have been included for the same factors there will be a change in their values to account for the difference in modelling.

An important feature of the calculation method is that the geometry used for determining all the correction terms is calculated in the plane passing through the receiver, normal to the railway segment. Thus for an oblique segment this geometry is obtained by extending the source line.

This is the same approach as in CRTN and ensures a consistent result for a uniform straight line railway even when split into a number of segments.

5. CONVERSION TO L_{Aeq}

The L_{Aeq} for operation of the whole railway is determined from the energy summation of the component parts.

For one train type, on one track within one segment

$$L_{Aeq,6h} = SEL - 43.3 + 10\log Q$$

$$L_{Aeq,18h} = SEL - 48.1 + 10\log Q$$

where Q is the total number of trains of each type over the appropriate time period.

6. MEASUREMENT

There will be situations where information is required but where it is felt that accurate estimation of noise levels can only be obtained by measurement. The memorandum offers advice on the appropriate use of measured data and the manner in which those measurements should be carried out.

7. SUMMARY

A chart based method "Calculation of Railway Noise" has been developed to accompany the draft of "Noise Insulation (Railway and Other Guided Transport Systems) Regulations 1993. This procedure follows closely CRTN and attempts to provide an accurate method of calculating moving train noise in a variety of common situations.

Comments on both documents have been requested by DTp before 31 December 1993.

8. ACKNOWLEDGEMENTS

Thanks are due to the Department of Transport for giving permission for this paper to be discussed. Further thanks are due to the other members of the working group for their patience and good humour during the preparation of the draft memorandum.

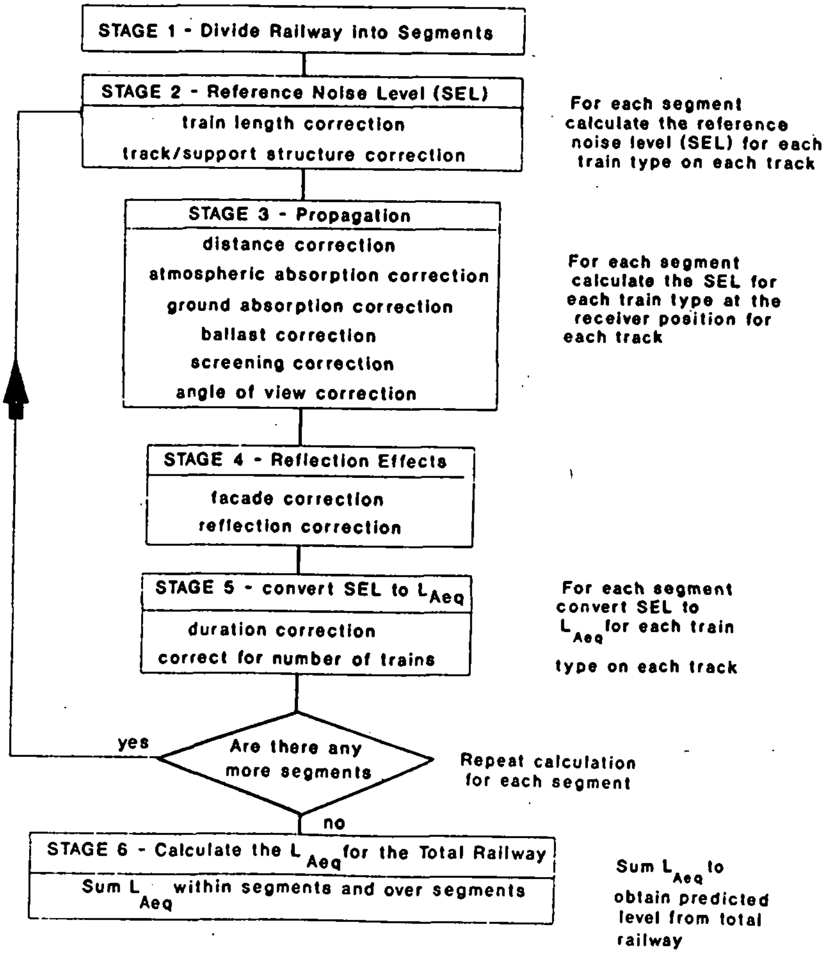

FIGURE 1 FLOW DIAGRAM FOR THE CALCULATION OF NOISE FROM RAILWAYS