Proceedings of the Institute of Acoustics

NOISE IMPACT ASSESSMENT OF THE CTRL

Dr R A Hood

Ashdown Environmental Limited

1. Introduction

1.1 An environmental impact assessment of British Rail's proposal to construct and operate the Channel Tunnel Rail Link (CTRL) was commissioned by British Rail. As part of that work, Ashdown Environmental Limited (AEL) undertook an independent specialist study into the noise impact of the CTRL as well as other environmental studies. This paper describes the methods that we have developed to assess the impact of this proposal on residential properties. There are five main areas of interest:

1. The units and indices to be used;
2. The subjective response to train noise;
3. The assessment of the impact of a new source of train noise;
4. The criteria for evaluating that impact;
5. The criteria for providing noise mitigation.

1.2 The effects on non residential property are briefly referred to at the end of this paper and suggestions for assessing the impact are given.

1.3 The views expressed in this paper are not necessarily those of the British Railways Board, although the impact criteria which have been developed have been used to assess the noise impact of the CTRL.

2. Units and Indices

2.1 Noise is defined as unwanted sound and there is general agreement that the best unit for assessing a steady continuous noise is that of the dB(A). However, external noise levels are rarely steady and rise and fall in response to activity within the area. In an attempt to produce a figure that relates this variability in noise to the subjective response of people affected by that noise, a number of noise scales or indices have been developed. These include:

1. L_{A10}
2. L_{A90}
3. L_{AMax}
4. L_{Aeq}

The L_{A10} and L_{A90} are not relevant to intermittent noise as in general these indices are not sensitive to changes in intermittent noise.

2.2 For intermittent noise, most people accept that their response to noise will be dependent on:

1. The number of events;
2. The duration of events;
3. The peak noise level (L_{AMax}).

The L_{Aeq} unit represents the average energy level of an intermittent sound and, can be readily calculated from the above factors. The L_{Aeq} scale therefore gives us a readily useable number that can be used to describe the noise climate produced by an intermittent noise. This unit has advantages over the L_{AMax} level as it is sensitive to changes in duration and number of events.

2.3 The results of social surveys which have examined the response to train noise confirm that the L_{Aeq} index is indeed the best index in assessing disturbance from this source and we have used this index in our work. In Table 1 the main findings of the various noise surveys into the disturbance caused by train noise are given. The above is not unexpected as for many years the L_{Aeq} unit has been used not only to assess train noise but also aircraft noise, construction noise and industrial noise.

2.4 There has been considerable debate as to the time period over which the L_{Aeq} unit should be assessed. With any railway operation there will be a proportion of train traffic during the night time period. It has been argued that the daytime, evening and night-time periods should therefore be assessed separately. However as there is, in general, a simple relationship between the 24 hour unit and the daytime, evening and night-time levels, once the 24 hour level is known the other levels can be readily calculated. In addition, as the 24 hour level is in general only 1 or 2dB(A) lower than the daytime level, it is not surprising that social surveys have not shown up any particular sensitivity to night-time noise.

2.5 In our opinion, the more important argument relates to the response of an occasional activity at night that causes a high noise level, and how can this be assessed? In our assessment methodology we have used a 24 hour L_{Aeq} unit but have also given the L_{AMax} (peak noise levels) as we have found that the public can more readily understand the L_{AMax} unit compared to the abstract value obtained by determining the 24 hour L_{Aeq}.

3. Assessing the Effects of a New Source of Train Noise

3.1 As discussed in the previous section, unlike noise from road traffic, train noise tends to have a high level short duration impact. The response of the community to such a noise is dependent on a number of factors including the proximity of the line; the source noise level; the number of trains and the level of conditioning or acceptance to this particular noise after it has become part of the normal environment. There is evidence however that people do not adapt to new noise sources from road traffic even after a period of up to 9 years. It is therefore difficult to be definitive on this aspect as this type of assessment is complicated by the fact that on average 50% of residents change houses at least every 5 years and if people are unhappy with the new noise source their propensity to move may be greater than if they were unaffected by the new noise source. Although in work that has been undertaken on the effect of housing turnover adjacent to a new road, this factor could not be isolated.

3.2 There are four different approaches that have been advocated to determine the subjective response to a new or different noise source. The first relates to noise change; the second to absolute levels; the third to a comparison of the new noise with the L_{90} background noise level (BS4142 methodology) and the fourth to audibility.

(i) Noise Change

3.3 The Department of Transport's Manual of Environmental Appraisal for Trunk Road Assessments (MEA) [1] outlines a system for describing the effects of a new road on the environment. In that system, the noise changes that are likely to occur with the proposal are calculated and these are presented in bands of noise change. The assumption is that the greater the noise change, the greater the subjective response to that change. This system has been used for both urban and rural situations and consequently in situations where a motorway is introduced into a quiet country area. In that type of locality, where the existing noise environment is determined mainly by local noise sources and vehicles passing on adjacent lanes are sporadic, the construction of a motorway or trunk road would introduce what is effectively a new noise source into the area and change the character of the acoustic environment.

3.4 Very little work has been published with regard to justifying this system or the descriptors of the various noise changes that have been identified. The basic assumption with this methodology is that a person experiencing a noise change from 45dB(A) to 70dB(A) is likely to be far more adversely affected than a person who experiences a change from 65-70dB(A). However, the method also assumes that a change of 65-70dB(A) can be equated to a noise change of 45-50dB(A) or 50-55dB(A). This is a matter for debate and interpretation, but it is considered that this is a reasonable method and can be applied to the impact assessment of the proposed CTRL. Support for this methodology can be found by analysing the TRRL work on the effect of bypasses [2].

(ii) Absolute Level

3.5 It has been suggested that the subjective response to a change in the noise environment will be entirely governed by the final noise level to which the subjects are exposed. That is, the subjective response to the new environment is related to the dose response relationship (i.e. the relationship between disturbance and noise level) that has been found from previous surveys. There is a correction that has to be added to this dose response relationship to take into account the introduction of a new noise source compared to the case of established noise sources. It has been suggested by Griffiths & Raw [3, 4] that a 5dB(A) correction is required for aircraft noise and a 10dB(A) correction is required for road traffic noise. There is no information on the adjustment required for new railways. The above corrections only have to be added when a change of at least 3dB(A) is experienced. It is considered that the absolute level of train noise does not provide an adequate measure of impact not only because of the problems mentioned above, but also if there is a decrease in the noise environment by providing noise barriers. This benefit cannot be readily identified in the above assessment.

(iii) BS4142 Methodology [5]

3.6 This methodology is used for rating industrial noise, and the Corrected Noise Level or corrected L_{Aeq} noise level is compared with the L_{A90} background noise level. Differences between the source noise level and the L_{A90} are used to judge the possibility of a noise nuisance arising. However, we have found no published work which justifies this methodology for transportation schemes and the foreword to BS4142 states that "it is intended to apply solely to noise from factories, industrial premises and to other fixed installations". Indeed, if this philosophy were applied to transportation noise complaints would be expected from virtually every road, railway and airport. A further problem associated with this method relates to the instability of the background noise levels (L_{A90}). From a 6 week extended survey, we determined that the daytime variation in the L_{A90} level had a standard deviation of approximately 3.3dB(A). This implies that if the L_{A90} noise level was measured for an hour one day then there is a 1 in 20 chance that the next day the level could be up to 12dB(A) different. However, with the 24 hour L_{Aeq}, the standard deviation was 1.6dB(A) which implies that 95% of measurements would be within $\pm$3dB(A). However, there appears to be a relationship (although not very accurate) between the L_{A90} in an area and the L_{Aeq}. It is therefore not unreasonable instead of describing the noise environment in an area by relation to the L_{A90} level to use the L_{Aeq} index instead and if the approximate conversion between the L_{A90} and L_{Aeq} is used then the criterion that we have derived relates reasonably well to those that can be derived using the above methodology.

(iv) Audibility

3.7 On a still quiet night, the background (L_{90}) noise level in Kent could fall as low as 25dB(A). In these situations, it is possible that the noise from the train would be audible up to a few kilometres from the track. However, in these types of conditions, train noise is already audible throughout most of the route. The significance of this audibility is not, in our view, a major element that should be incorporated into the assessment of environmental effects. The results of a National Noise Survey [6] showed, for example, that although 35% of the population could hear train noise, only 2% of the population were bothered by it. Consequently we consider that an audibility criteria is inappropriate for this project, as indeed it is for other transportation schemes.

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Selected Noise Impact Measures

3.8 In summary, it is considered that, as we are undertaking an environmental impact assessment, we are required to calculate the changes in the environment that occur with this proposal, and we should endeavour to describe the changed environment in terms of a change in the noise level experienced. However, regard will also have to be taken of the final noise level that properties are likely to be subjected to, the peak noise level, night time noise levels and the changing noise climate over time, when making recommendations for the provision of measures to reduce train noise exposure.

3.9 Research has shown that the onset of sleep disturbance occurs when the external night time noise level from trains exceeds a peak noise level of 85dB(A) for less than 20 occasions during the night. It is probable that a two way flow of up to 20 trains per night on the CTRL will occur by the design year. Residents of properties that experience peak (L_{AMax}) facade noise levels of 85dB(A) or more may therefore suffer sleep disturbance. We consider this to be a significant adverse environmental impact, and we are examining mitigation measures to overcome the effects of this.

Criteria for Evaluating Significance of Noise Impacts

3.10 The findings of our analysis of research into the effects of train noise on community reaction indicated that the L_{Aeq} index and specifically the 24 hour L_{Aeq} index correlates best with the annoyance induced by railway traffic noise. The advantage of using the 24 hour L_{Aeq} index over any other time period is that the noise dose for the whole day can be represented in one number. However, if the L_{Aeq} noise level over any other period is required, this can be readily calculated from a knowledge of the distribution of trains throughout the 24 hour period.

3.11 The level at which a new noise source becomes a major noise within an area is, in our opinion, the level at which there is a change in the noise environment of 3dB(A). This would occur when the new noise source equals or exceeds the existing noise.

3.12 It is clearly useful to categorise the degree of impact according to the extent of the predicted noise change. In order to describe the noise impact in simple terms, we have identified the following semantic differentials which we believe adequately describe the degree of impact of various noise changes.

Changes in $L_{Aeq,24hr}$ Noise Level	Description
3-5dB(A)	Slight
6-10dB(A)	Moderate
11-15dB(A)	Substantial
>15dB(A)	Severe

3.13 The results of the noise impact assessment have been presented in the form of noise impact plans. These show the baseline noise level assessed for each property, the future total noise level (both of these in terms of 24 hour L_{Aeq}) and in addition, we give the L_{AMax} level so that the general public can have some indication as to the maximum noise level that is likely to be experienced.

Non Residential Property

3.14 So far in this paper we have dealt with the noise impact on residential property. With regard to non residential property, we have suggested that there be a two stage criteria. First the noise from the CTRL must exceed the baseline level, i.e. there is a 3dB(A) increase in the noise environment of these properties. If this criterion is exceeded, the noise level on these non residential properties has been rated according to the table overleaf.

	$L_{Aeq,24hr}$ External Noise Level		
Location	**Good**	**Acceptable**	**Poor**
Schools	55	65	75
Hospitals	50	55	65
Churches	55	65	75
Offices	60	70	80
Public Open Spaces	50	60	70

4.0 Noise Mitigation

4.1 Where any of the noise criteria are exceeded, consideration will be given for the need and practicality of noise mitigation at source. The case for noise mitigation is considered on individual merits, and the following will be included in the decision as to whether noise mitigation will be provided:

1. The final increase in noise level predicted;
2. The final noise level achieved;
3. The number of properties affected;
4. The impact of any potential mitigation, for example, the visual impact of barriers;
5. The engineering practicability of installing a barrier or bund;
6. The cost of mitigation.

4.2 Noise mitigation will, in general, be provided by either a noise barrier or noise bunds. Efficiency of any noise barrier or bund will be dependent upon the particular topography adjacent to the track at these locations. However, in general, it can be assumed that the closer the noise barrier or bund to the track, the more efficient the barrier and the higher the barrier or bund, again the more efficient.

4.3 In determining the precise height and location of noise barriers or bunds, there are a variety of factors that need to be taken into consideration as these barriers have the potential in themselves to cause considerable environmental problems, such as loss of valuable land, reduction in visual amenity, etc. The proposed noise barriers and bunds will therefore have to be carefully considered in order that these proposals blend in with the existing landscape or townscape and provide not only an improved aural environment, but also a good visual environment.

5. REFERENCES

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Country Of Origin	Measure Of Community Response Used	Noise Index	Comment
UK (Fields & Walker [7])	General Annoyance	$L_{Aeq,24h}$	Percentage very much annoyed : ≤ 10% at 65dB(A)
France (Aubree [8])	General Annoyance	$L_{Aeq,24h}$	All respondents disturbed : ≥ 76dB(A)
France (Vernet [9, 10])	Disturbance	$L_{Aeq,12h}$ (08.00 - 20.00)	Percentage disturbed and very disturbed : 50% @ 73dB(A) < 20% @ 60dB(A)
Switzerland (Heintz et al [11])	General Annoyance	$L_{Aeq,day}$	Increase in reaction at 53dB(A)
Netherlands (Peeters et al [12])	General Annoyance	$L_{Aeq,24h}$	Increase in reaction at 50dB(A).
Denmark (Andersen et al [13])	General Annoyance	$L_{Aeq,24h}$	Percentage strongly annoyed : 9% at 60dB(A), 20% at 65dB(A)
Sweden (Sörensen & Hammar [14])	General Annoyance	L_{AMax}	Percentage very annoyed : 20% at 85dB(A)

TABLE 1 : MAIN FINDINGS OF PREVIOUS RESEARCH INTO THE EFFECTS OF TRAIN NOISE ON COMMUNITY REACTIONS