NOISE FROM THE DOCKLANDS LIGHT RAILWAY - IS L_{Aeq} A SUITABLE MEASURE?

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INTRODUCTION

Previous surveys of community response to railway noise in this country [1,2] have shown that noise from railways is generally regarded as less annoying than that from aircraft or road traffic, and also that 24 hour L_{eq} in dB(A) is more closely related to annoyance than any other accepted criterion.

These studies, however, were confined to the response to conventional railways. With the introduction into this country of urban light railway systems, which create a different type of sound, it becomes important to examine the effects on the local community of noise due to such systems, and to determine whether or not L_{eq} continues to correlate satisfactorily with noise annoyance.

THE DOCKLANDS LIGHT RAILWAY

The Docklands Light Railway (DLR) commenced operations in August 1987. At present the railway runs due east from Tower Hill to Limehouse, where it divides into two sections, one going north to Stratford, and the other south through the middle of the Isle of Dogs (see figure 1). Along much of its length the railway passes close to dwellings of various types and ages, including large blocks of flats and Victorian terraced housing.

The railway consists of many different types of track construction. In some places the rails run on old brick viaducts or embankments; some sections consist of ballasted track at ground level; and there are long sections of new elevated structures constructed of steel and concrete.

DLR NOISE SPECIFICATION

Prior to construction of the railway the Docklands Light Railway Company laid down the following noise specification: the free field A weighted L_{eq} should not exceed the following levels:

Daytime (0700-1900)	Evening (1900-2300)	Nighttime (2300-0700)
60	55	50

In addition the peak noise level should not exceed 75 dB(A).

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Local residents who were worried about possible noise annoyance were informed of these limits with the assurance that these levels would not cause annoyance.

COMPLAINTS

During testing of the railway local residents complained about the noise levels of trains. Since the railway started operating a full service the number of complaints has increased from residents along almost the whole length of the railway. From the nature of the complaints, those residents who appear to be most upset by the noise are those living near to the new elevated sections of track. The authors were asked to carry out a survey of noise all along the track, on behalf of the local residents, to determine whether or not their complaints could be justified, and whether the railway noise complied with the specifications laid down by the DLR.

RESULTS OF THE SURVEY

Noise levels were measured both inside and outside dwellings at selected sites along the railway, near to a variety of different track constructions. Measurements were made during the evening when noise from construction sites and road traffic was at a minimum. The measurements showed that the noise which appeared to be the most disturbing to residents, occuring at sites near to the new viaducts, contained very high levels of low frequency noise. Figure 2 shows examples of average spectra measured outside at several such sites together with a typical spectrum recorded near an old brick viaduct. It can be seen that the noise measured near new viaducts has a very high peak in the 63 Hz octave band. At one site individual trains showed peak levels as high as 100 dB at this frequency.

Table 1 gives examples of the overall maximum sound levels in both dB(linear) and dB(A) due to individual trains at this same site. Comparison of the two levels, with differences of up to 23 dB, gives a further indication of the high component of low frequency noise.

It was found that typical levels giving rise to annoyance range from 75 to 77 dB(A), with corresponding linear levels of 86 to 101 dB. Measurements elsewhere on the railway are in the range 70 to 75 dB(A) with corresponding unweighted levels of 75 to 80 dB.

At certain sites L_{Ax} in dB(A) was measured for a number of trains, and the average used to calculate the daytime, evening, and nighttime L_{eq}, the number of trains passing during each period being taken from the published timetable.

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Results for some typical sites near to the new viaducts are shown in Table 2.

It can be seen that in all cases the daytime limit is complied with, although the evening and nighttime limits are exceeded.

USE OF dB(A)

The A weighted decibel has been adopted by British and International Standards institutions for the assessment of environmental noise as it is assumed to correlate well with annoyance caused by noise. However on the Docklands Light Railway it is precisely the sound containing high levels of low frequency noise that is causing most annoyance to local residents.

It would therefore appear that, in this case at least, the use of dB(A) significantly underestimates the degree of annoyance caused by a particular sound.

USE OF L_{eq}

L_{eq}, expressed in terms of dB(A), is also increasingly used as a measure of environmental noise, and for the assessment of the impact on a community of new noise sources.

A proportion of the complaints of noise levels from the railway concern so called "startle" effects such as being woken up early in the morning or kept awake at night by high noise levels of comparatively short duration. The use of L_{eq} for the evaluation of such sounds would appear particularly inappropriate.

Noise has the greatest adverse effect on the community during the period 1900-0700 when it is more discernable than at other times owing to the lower level of background noise. It is during this time that the disturbance due to the trains takes such form as waking people up and interfering with television. Yet the use of L_{eq} for the periods 1900-2300 and 2300-0700 can be misleading because the reduction in the number of trains alone during these periods gives a drop in L_{eq} of up to 5 dB. However, because the number of trains is fewer, each one produces more of a "startle" effect than when the trains are running more frequently.

USE OF L_{Aeq}

The above argument implies that the use of L_{eq} for the assessment of noise arising from individual events causing high noise levels is not appropriate. In the case of noise due to the Docklands Light Railway the high level of noise caused is obscured by the use of dB(A), and when these already underestimated levels are averaged to give L_{eq}, no indication is given of the serious nature of the problem caused.

It might be argued that the fact that evening and nighttime specifications for L_{eq} are being exceeded shows that disturbance can be expected. However the differences between calculated and specified values, of up to 4dB, do not indicate sufficiently the degree of disturbance experienced by residents.

ALTERNATIVE CRITERIA

It appears from the measurements carried out, and the community response to different types of noise arising from the Docklands Light Railway, that there is a need to develop new criteria for the assessment of transport noise which is mainly low frequency in character, and occurs very close to dwellings.

Criteria have been proposed in recent years for the assessment of low frequency noise emanating from industrial premises. For example Dawson [3] describes the community noise criterion curve which is used by Rolls Royce to determine the likely reaction of the local community to noise arising from their factories, and Boner and Leventhall [4] have proposed a set of Low Frequency Noise Rating (LFNR) curves. Although the Rolls Royce community noise criterion has been designed for the assessment of continuous noise, it is interesting to plot on it typical average sound spectra measured outside dwellings near the new DLR viaducts, as shown in figure 3. The curve gives some indication of the strong community reaction that might be expected from the noise levels that are occurring.

Because of the high number of trains on light railway systems, it is also thought that it might be more appropriate to use criteria involving L_{10} or L_{90}, as in the case of road traffic noise, rather than L_{eq}.

CONCLUSIONS

It would appear that the noise levels on the Docklands Light Railway causing most annoyance to residents are those containing high levels of low frequency noise. Therefore the use of dB(A) in these circumstances does not provide an adequate measure of the local community reaction. The effects of such noise are further underestimated by averaging the sound levels of trains over a certain period to give L_{eq} values. It therefore would seem from our survey that the use of L_{Aeq} in the assessment of community response to noise from the Docklands Light Railway is doubly inappropriate, and that further research is needed to develop suitable criteria for the assessment of such noise.

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REFERENCES

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2. Fields, J.M. and Walker, J.G. The response to railway noise in residential areas in Great Britain. J. Sound and Vibration 85 (1982) 177-255

3. Dawson, H. Practical aspects of the low frequency noise problem. J. Low Frequency Noise and Vibration 1 (1982) 28-44

4. Broner, N. and Leventhall, H.G. Low frequency noise annoyance assessment by low frequency noise rating (LFNR) curves. J. Low Frequency Noise and Vibration 2 (1983) 20-28

Table 1

Examples of maximum noise levels of individual trains measured near Mudchute Station.

dB(A)	dB(lin)
79	97
79	101
76	98
75	98
75	97
79	97
79	100

Table 2

Calculated L_{eq} levels at sites near new viaducts.

	Daytime	Evening	Nighttime
Thermopylae Gate	58	58	53
Manchester Road	57	56	53
East Ferry Road	58	57	54
DLR specification	60	55	50

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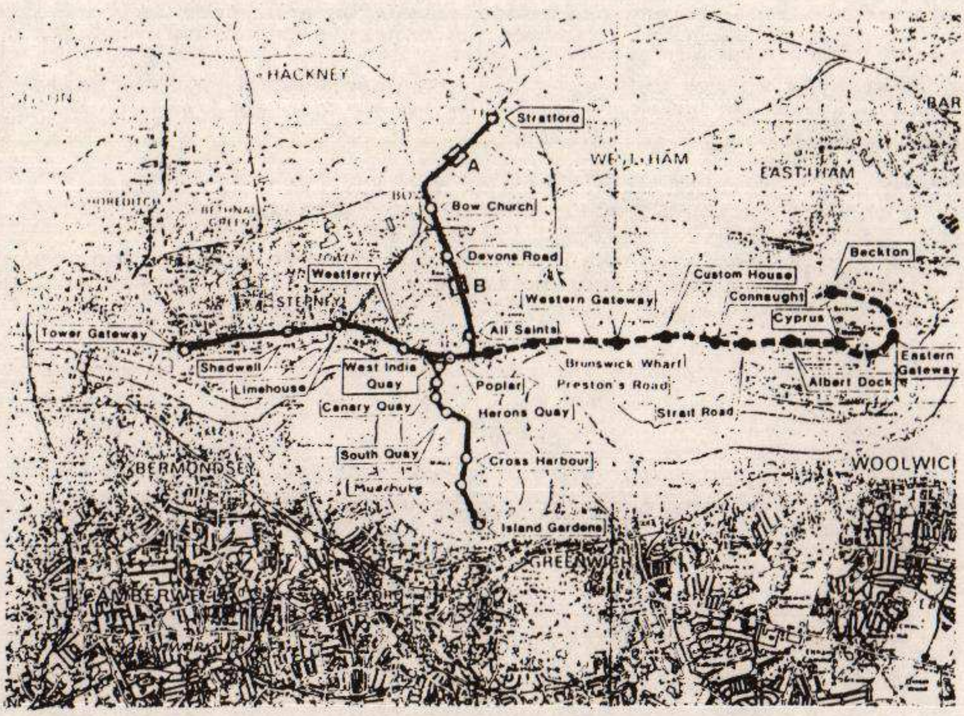

Figure 1   Map of the Docklands Light Railway

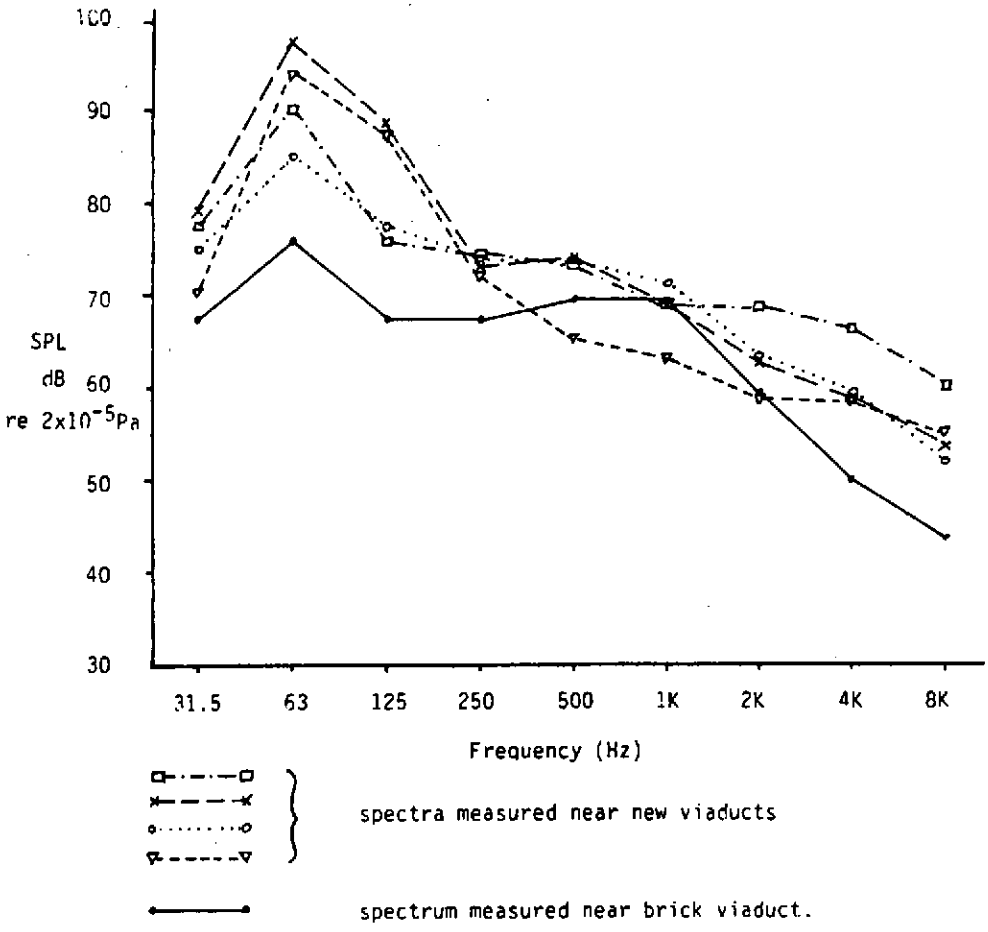

Figure 2 Typical average noise spectra measured near the Docklands Light Railway

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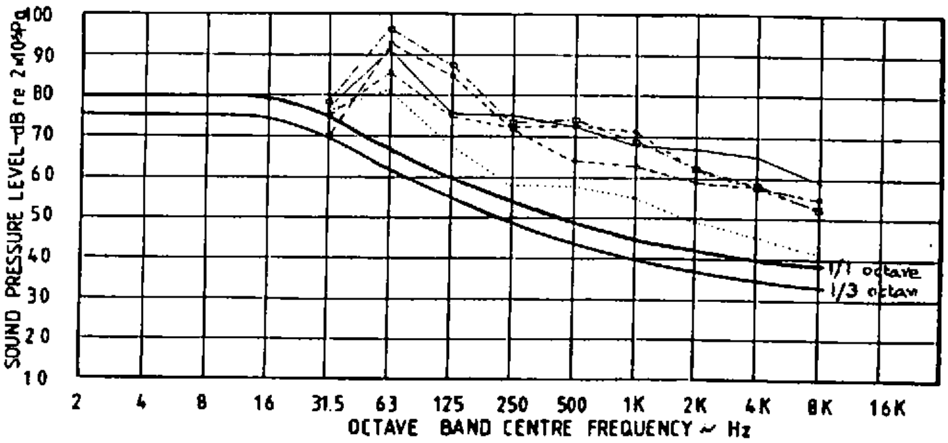

Figure 3 Noise spectra measured near new viaducts plotted on the Rolls Royce community noise criterion curve