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DIURNAL ASSESSMENT OF BACKGROUND NOISE

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ABSTRACT

This pilot study investigated extensively a small sample of day and night background noise in order to determine the significance of the choice of weighting filter, percentile value and measurement duration. Tape recorded day and night background noise was processed to determine Leq, Lmax, L_1, L_5, L_{10}.....L_{90}, L_{91}.....L_{99} for ten octave bands and 'A' filter. The variation between day and night frequency spectrum suggests that the choice of filter characteristics is important. The shape of the cumulative distribution in the L90-L99 region changes significantly between day and night indicating that the choice of L90/L95 as background level may be critical. The confidence limits of background level values for different measurement time were determined. This paper suggests the type of investigation which should be undertaken by as many centres as possible in order to clarify the concept of a determinable background level.

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INTRODUCTION

Bristol Polytechnic has investigated industrial noise complaints for a number of years with a growing concern for the determination of a representative background noise level. The environmental noise problem is widely documented, for example (1) and (2) and it is clear that the general public is becoming less willing to tolerate industrial noise and in order to address this problem acousticians must continue to refine the methods of noise assessment. Although many surveys, for example (3), conclude that transportation noise is the main problem, in 1981, 18,925 industrial noise complaints were received by Environmental Health Departments in the UK (4) and in 1980 the Organisation for Economic Co-operation and Development reported, (5) that industrial noise can have a considerable impact on residents and could become even more significant. In deciding whether a statutory noise nuisance exists, the courts welcome technical evidence, (6) and this implies the use of relevant British Standards, and in 1973 Local Planning Authorities were required, (7) to use the British Standards BS 4142, (8) first established in 1967, which rates industrial noise by comparison with the background noise level. The use of an existing or expected level of noise, background noise, can be traced back to the nineteenth century, for example the Thesiger L.J. Rule: "what would be a nuisance in Belgrave Square would not necessarily be so in Burmonsey", Sturges v Bridgman, 1879, 11 Ch. D.852. This background noise was more clearly defined in the amendment to BS 4142 in 1975 when the time varying properties of the 'A' weighted sound pressure level was acknowledged by choosing a percentile method of assessment, in particular the ninety percentile, although no measurement period was specified, the latest redrafting of BS 4142 still retains the ninety percentile method. This British Standard has been criticised by some, (9) for being inappropriate in complex environments, however The International Standards Organisation also bases the assessment on the background level of noise, (10) but chooses the level exceeded for ninety five percent of the time as the background level. There appears to be a lack of published work justifying the choice of either L_{90} or L_{95} as the background level, however most researches, e.g. (11) prefer the percentile approach.

RESULTS

A pilot study was undertaken by analogue tape recording from 10.10 pm to 1.26 am and from 10.50 am to 1.50 am on 11/12th February 1987. This recording was extensively analysed in the hope of isolating the more interesting parameters or at least determine the sensitivity of choice of such things as 'A' filter, L_{90} or L_{95} and length of sampling period and to compare day with night time results.

The frequency components were investigated using linear and A filter and octave bands from 31.5 Hz to 16 k Hz and time variation by determining L_{eq}, L_{max}, L_1, L_5, L_{10}.....L_{90}, L_{91}.....L_{99}.

The sampling error was investigated by sub-dividing the three hour recordings into 5, 10 or 15 minute periods and determining the L_{eq}, L_1, L_{10}, L_{50}, L_{90}

and L_{95} for each period.

Frequency spectrum: Figure 1 shows the octave band spectrum for day and night selecting L_{eq}, L_{90} and L_{95} the choice of time variation assessment does not appear to be particularly significant as the curves are similar. Figure 2 has selected L_{eq} and compares the day and night time spectrum and suggests a marked reduction of the 2-4 kHz frequencies at night time giving a more pronounced 'hum' at night. Bristol City Council have received many complaints of low frequency hum at night (12) and similarly in West London (13). As night time noise is mostly heard indoors the mass law further enhances the hum effect (14) and makes the spectrum particularly sensitive to the 'A' filter.

Time variation: The percentile level for each octave band was obtained and with similar results for all frequencies, Figure 3, illustrates the general shape using 63 Hz and 2 kHz band. Each octave band results show a similar shape for day and night except in the region L_{90} to L_{99}, the night time percentiles changing more rapidly. This is clearly shown in Figure 4, where the 'A' weighted level is used there being about 1 dB differences between L_{90} and L_{95} during the day and a 5 dB difference between L_{90} and L_{95} at night. Thus with the results obtained a change in the definition of the background level percentile would not change the day time assessment but could significantly affect the night time values.

Sampling period: In this study a three hour sample was used for analysis. This recording was then broken down into 5, 10 and 15 minute samples to determine, for example, how many five minute samples would be required to give a reasonable estimate of the complete three hour period. Figure 5, shows that a minimum of seven five minute samples are required during a three hour period to give the true three hour value within an error band of $\pm$ 2dB with a 95% confidence limit, similarly ten samples are required to increase the confidence limit to 99%. Our results indicate that extensive sampling is necessary if reasonable accuracy is required. A similar study (15) concludes that only under a very limited set of conditions can samples be assumed to be representative of an extended period unless errors greater than $\pm$ 2dB are acceptable, this study further concludes that particularly for L_{90}, L_{95} and L_{99} estimates, errors are reduced if the five minute sample is constructed from thirty ten second sub-samples. This approach will reduce the data handling capacity of monitoring equipment but it appears that long term monitoring is still required.

CONCLUSION

The nature of background noise should be further researched if it is to continue as a base for industrial noise assessment, perhaps an easier solution is to make more use of Noise Abatement Zones and planning consent procedures.

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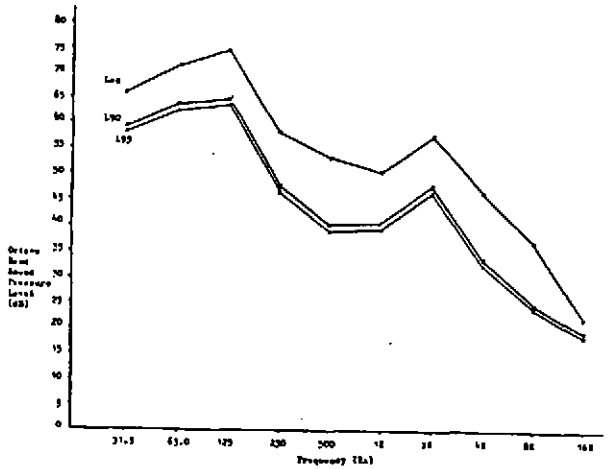

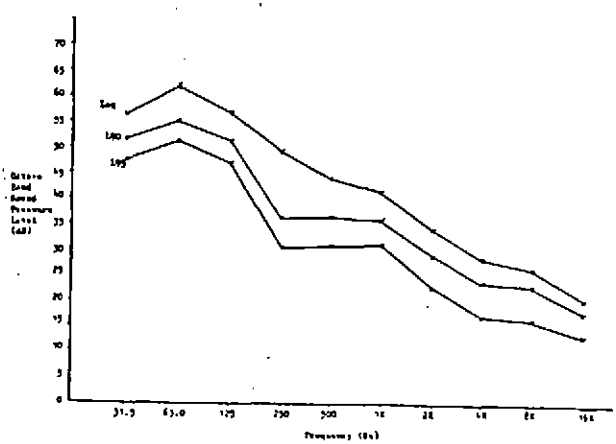

Figure 1. Octave band L_{eq}, L_{90} and L_{95} noise levels for day (top) and night (bottom).

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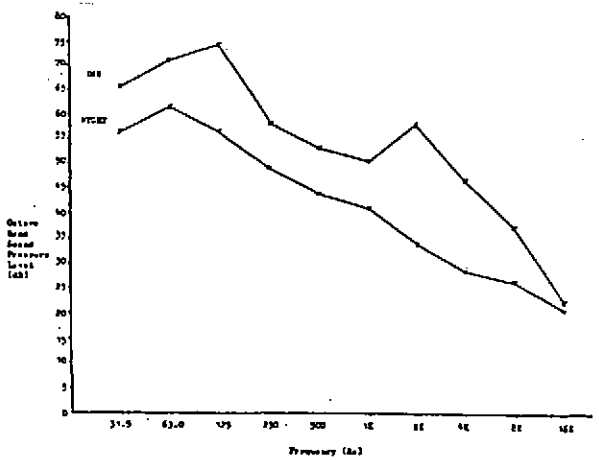

Figure 2. Octave band L_{eq} noise levels for day and night.

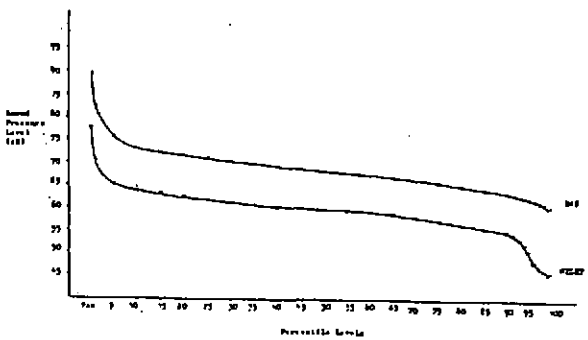

Figure 3a. 63 Hz octave band percentile levels for day and night.

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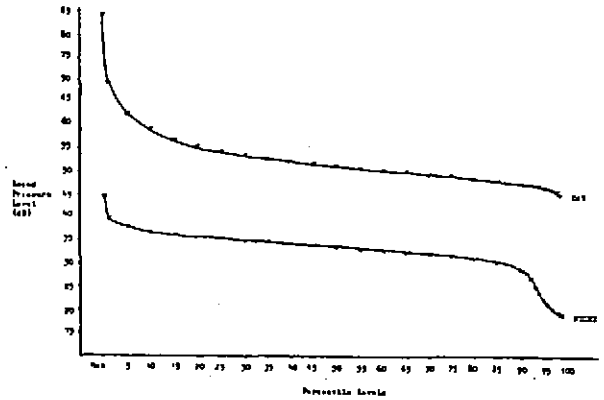

Figure 3b. 2 kHz octave band percentile levels for day and night.

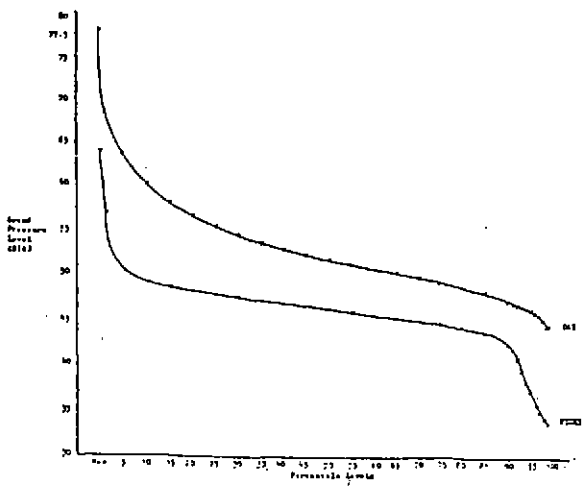

Figure 4. 'A' weighted percentile levels for day and night.

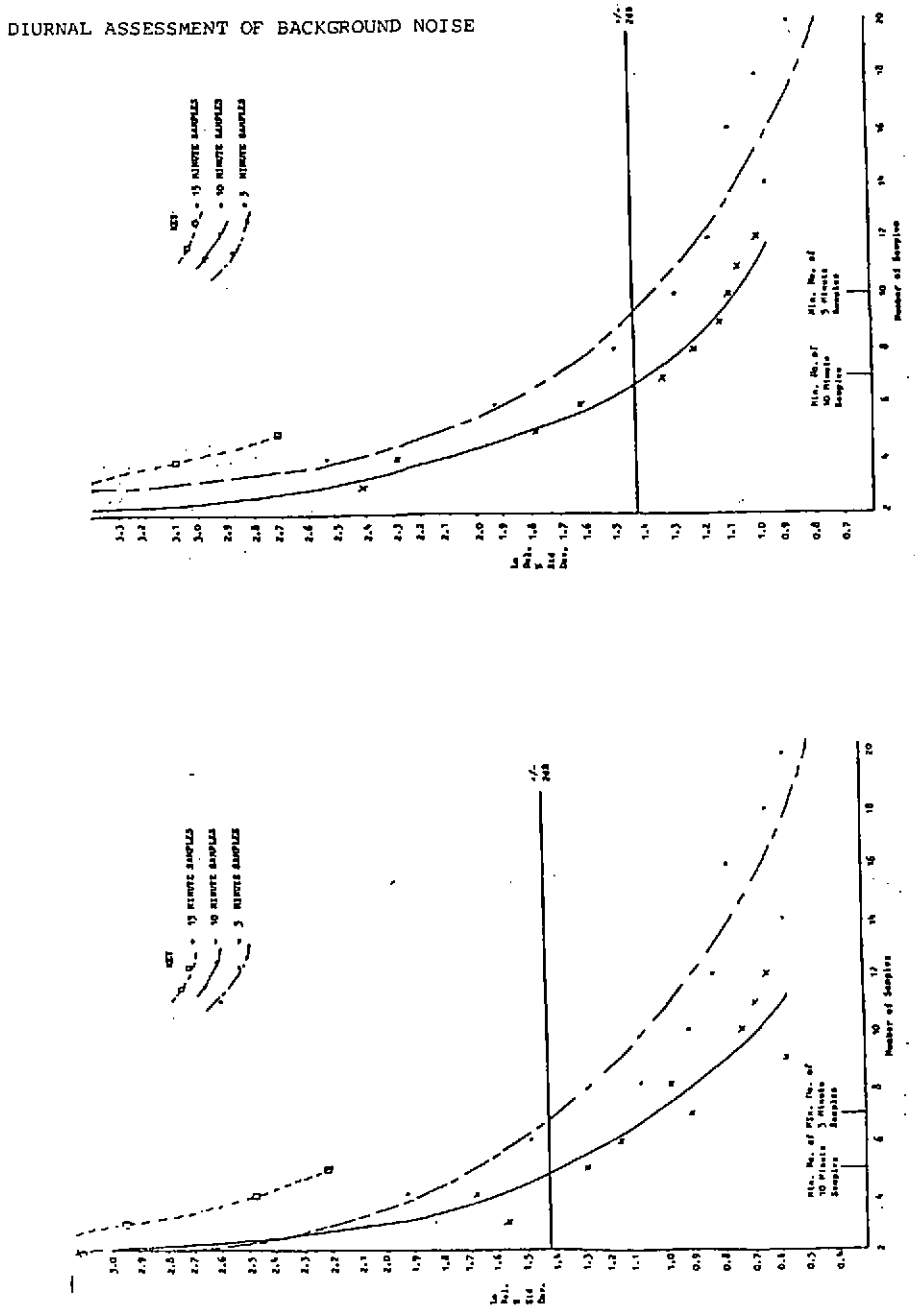

Figure 5. Minimum sample requirement to obtain the L_{90} during a 3 hour daytime period for a confidence limit of 99% (top) and 95% (bottom).