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BACKGROUND NOISE - WHICH L90 ?

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1. INTRODUCTION

In the rating of noise of an industrial nature an appropriate value of the background noise level is required.

This paper will address a number of different situations, including the time of day that the source will be operating, day of the week and which way the wind is blowing.

2. Definitions and Symbols

Residual noise

The ambient noise remaining at a given position in a given situation when the specific noise source is suppressed to a degree such that it does not contribute to the ambient level.

Background noise level $L_{A90,T}$ dB

The A-weighted sound pressure level of the residual noise that is exceeded for 90% of a given time interval, T. The time weighting F shall be used. The background noise level is quoted to the nearest whole number of decibels.

3. Case 1

A specific noise source is due to operate from 23.00 to 07.00 at a position that is 20m from the nearest residential property and an appropriate bnl is required for rating purposes. The bnl is partly determined by the distant M1 and partly by the local traffic noise.

Consequently the background noise level must be measured during the night, in particular between the times of 23.00 to 07.00 hours.

The measurement period shall be sufficiently long to obtain a reliable result.

The selection of which night to measure over will depend on whether the source will be operating at weekends.

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My preference is to measure the hourly values and select the lowest measured value (providing that the source will be operating at that time but is not operating at the time of measurement).

An alternative is to make a single measure of the $L_{A90,T}$ over a long time period of in this case up to 8 hours (but not more than the eight hours) and within the time zone of 23.00 to 07.00. This will normally yield a higher value than the lowest single hourly value. In this particular location where there is a long low period the difference is only 1 dB.

The practice of measuring the hourly values and arithmetically averaging them over the 8 hours is not mathematically sound. It will give a higher value than selecting either the lowest measured individual hourly value or the L_{A90} as measured over the complete period. Further that practice is not in accordance with the definition of background noise since it does not produce the L_{A90} over that period of time. In this example there is only a very small difference between the two results. In other locations the difference can be very significant.

Remember the hourly value of the $L_{A90, 1hr}$ is controlled by the quietest 6 minutes of measured noise and the $L_{A90,8hr}$ by the quietest 48 minutes; note the quiet period can be made up of a number of shorter periods.

In this case the propagation distances are small and also being at night when it is frequently calm it is less important to consider wind direction see figure 1.

4. $L_{A90,T}$ vs $L_{Aeq,T}$

Another consideration is the practice of wanting to measuring the background noise level in terms of an $L_{Aeq,T}$

It has been stated that the $L_{Aeq,T}$ is a more stable descriptor than an $L_{A90,T}$ (that is having a lower standard deviation). It also gives the advantage of comparing like descriptor against like descriptor.

Consider trace 1 This shows the time history over the whole eight hour night time period. The underlying level is clearly around 30 dB, this is more clearly shown in the trace 2 which gives the plot over the hour from 02.00 to 03.00, and trace 3 selects the time period 02.45 to 03.00 and trace 4 selects the a 10 minute time period.

Table 1 gives the hourly values of both the $L_{A90,T}$ and the $L_{Aeq,T}$ together with the values calculated over the complete 8 hour period from 23.00 to 07.00.

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It is clear that the equivalent continuous values are considerably in excess of the underlying level. Neither the $L_{Aeq\ 8hr}$ value of 45 dB nor any of the $L_{Aeq\ 1hr}$ values that range from 37 to 49 dB are remotely near the $L_{A90,T}$ value. Note there are periods of quiet when the distant M1 can be clearly heard.

Time T	$L_{A90,T}$	$L_{Aeq,T}$
	(dB)	(dB)
23.00 - 00.00	34	46.7
00.00 - 01.00	31	45.2
01.00 - 02.00	30	39.4
02.00 - 03.00	30	37.5
03.00 - 04.00	33	39.6
04.00 - 05.00	31	42
05.00 - 06.00	32	45
06.00 - 07.00	36	49.9
23.00 - 07.00	31	44.9

Table 1

5. WHICH L90?

Measurement at sites where the source or sources of the background noise are at significant propagational distances it is imperative to consider the wind speed and direction. It is obvious that the specific noise will be loudest at the nearest residence when there is a south westerly wind. Thus the background noise level should be measured when there is a south westerly wind. Also consideration of the wind speed should also be given, for it is illogical to compare a specific noise level measured with a light south westerly breeze with a background noise level measured in a gale. That is compare like with like.

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Further it is my considered opinion that it is wrong to compare measurements taken under unlike weather conditions. What is required is a fair value of the background noise level measured at a time when the specific noise will be operating but is not operating at that particular time.

If a specific noise source is some 70 m south west of the nearest residential property.

Wind direction	L_{A90} 30 min (dB)
SW	45
NE	35

Table 2

If the specific noise is measured with a SW wind then the appropriate value of the background noise level L_{A90} is 45 dB

In certain locations when the background noise level is measured under similar weather conditions the value varies.

Wind Direction	$L_{A90, 30min}$
	(dB)
calm	36.5
calm	37
calm	53.5

Table 3

For example under calm conditions at the same measurement location the following was obtained:

One is clearly very different from the others. The reason two were measured on a Sunday and the other one on a Tuesday.

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If however the background noise level on a Saturday with a SW wind varies for example:

These were some results that were measured under similar conditions. The background noise level is 45 dB.

Wind direction	$L_{A90, 30min}$	Day
	(dB)	
SW	44.5	Sat
SW	45	Sat
SW	47.5	Sat
SW	49	Sat
SW	49.5	Sat
SW	50	Sat
SW	50	Sat

The more frequently

Table 4

the specific noise is likely to operate under a specific set of conditions then it is important to select a typical low value of the background noise level.

6. Low background noise levels

In the current version of BS4142 it states in the Scope that the method is not applicable in situations where the background noise level is very low ie below an A-weighted sound pressure level of 30 dB.

Consider a case where the rating level is 39 dB and the background noise level is 29 dB.

A strict interpretation of the standard would say that the assessment procedure is inappropriate. However if the background noise level was 30 dB then the assessment level would be 9 dB and conclusion that complaints likely.

Consequently a modification of the wording of this part of the standard is required.
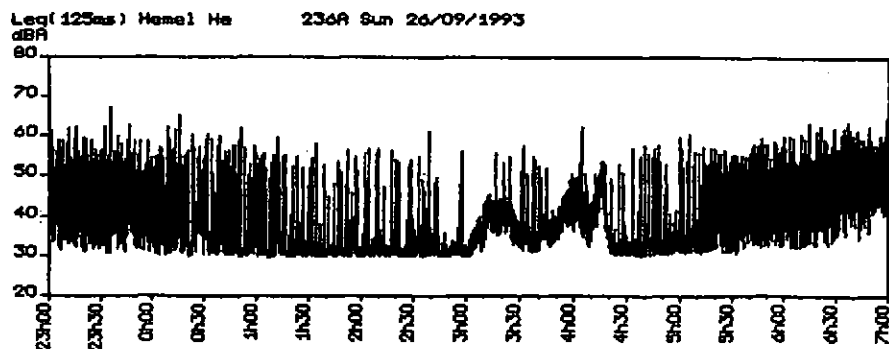
BACKGROUND NOISE - WHICH L90?
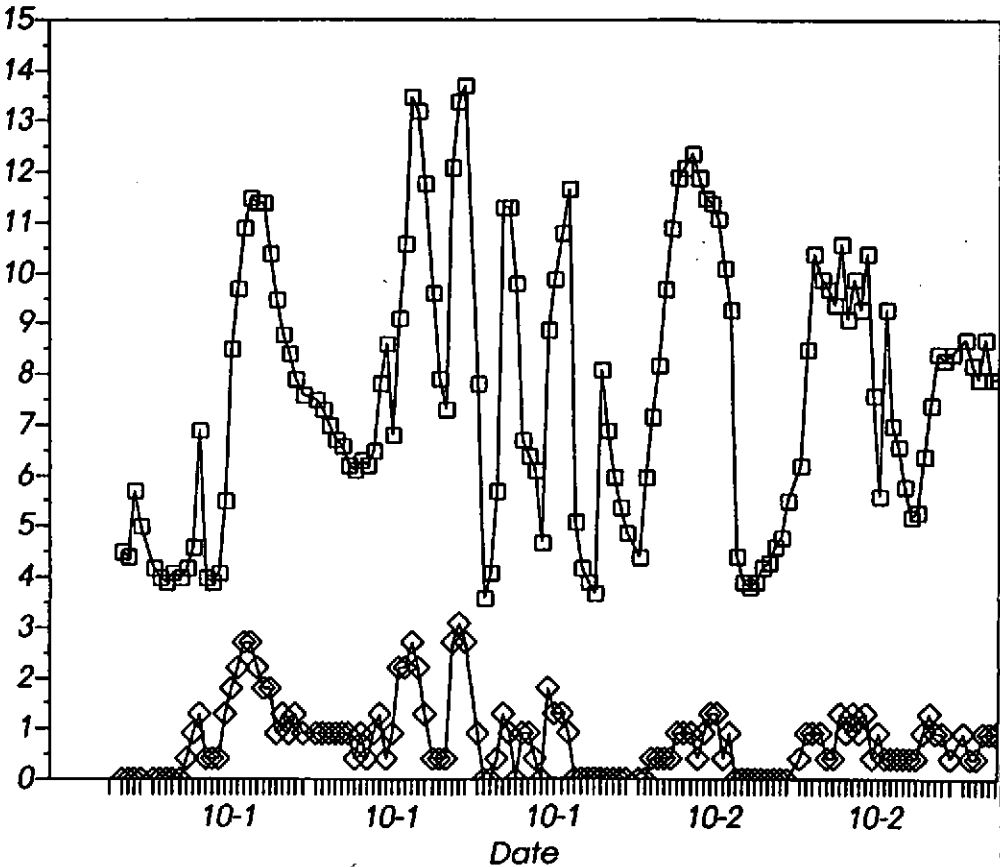
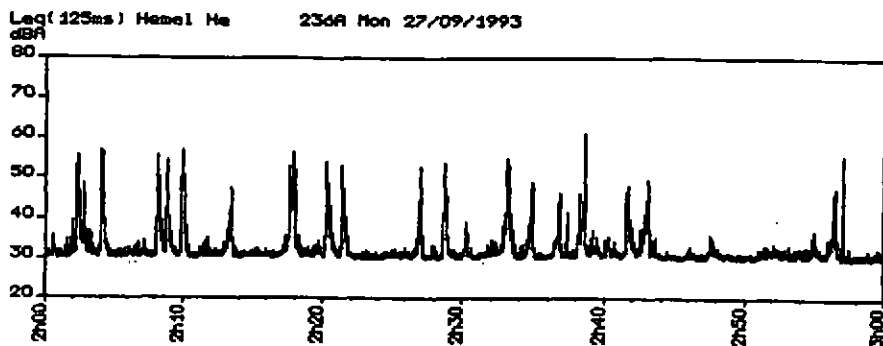The upper curve is a plot of outside temperature against time; the lower is the windspeed against time.

Figure 1

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Leq(125ms) Hemel He   236A Sun 26/09/1993

Trace 1

Leq(125ms) Hemel He   236A Mon 27/09/1993

Trace 2

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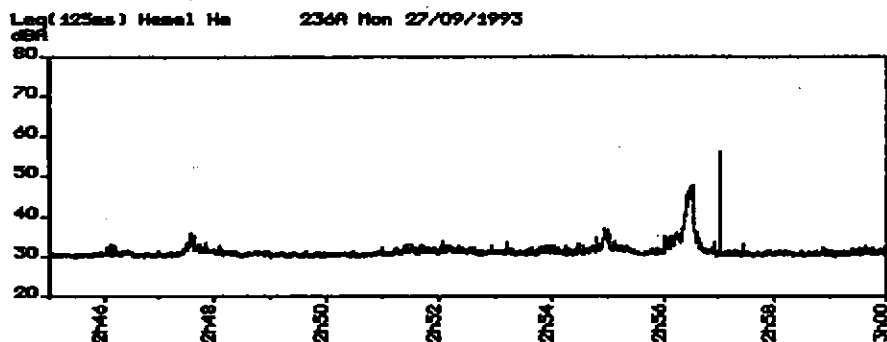
Trace 3
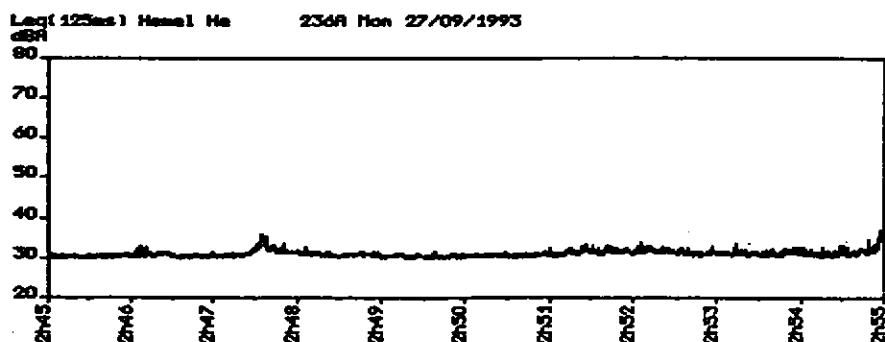
Trace 4

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Approximate formula for combining 90 Percentile Levels.

(H.G. Leventhall and J.P. Seller)

If N_1 is the percentile level over a time period t_1

and N_2 is the percentile level over another time period t_1

and if $N_2 > N_1$

Then the percentile level over the combined period $2t_1$

$$L_{N\ 2\ t_1} = \frac{N_2 + \left(N_2 - N_1 \right) N_1}{\left(N_2 - N_1 + 1 \right)}$$

eg $L_{A90\ 15min} = 40\ dB$

$L_{A90\ 15min} = 50\ dB$

Then $L_{A90\ 30min} = \dfrac{50 + (50 - 40)\ 40}{(50 - 40 + 1)} = 40.9\ dB$

$= 41\ dB$

REFERENCE

1. BS 4142 : 1990 Rating industrial noise affecting mixed residential and industrial areas