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MEASUREMENT PARAMETER, PERIOD AND POSITION

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1. Introduction

Following the publication of the revision of BS4142 -1990 I have received many questions on the interpretation and application of that standard. This paper will address some of those questions.

2. Background Noise Level L_{A90T} vs $L_{Aeq\,T}$

The background noise level is the underlying level that exists in a particular location prior to the introduction of a new noise source (the specific noise). The most suitable parameter to determine the underlying level is the percentile level.

Measurement of the pre-existing level in terms of an equivalent continuous noise level will yield an Environmental Noise Level. The Environmental Noise Level is a perfectly valid measure but has no relevance to either:

- ☐ BS4142,
- ☐ subjective evaluation of the baseline or underlying level.

The $L_{A90\,T}$ is a measure of the quiet periods of the fluctuating level and thus measures the underlying level.

Figure 1 shows a plot of the A-weighted Sound Pressure Level vs time where the background level is 47 dB.

Figure 2 is the same as figure 1 with the equivalent continuous level shown as a dotted line which is 50 dB at the end of the first minute and just over 50 dB at the end of the trace. Clearly the equivalent continuous level is *not* the underlying level.

Thus background noise level shall be measured in terms of a ninety percentile A-weighted level with a fast time weighting.

3. Fast vs Slow time weighting

The use of the slow time weighting is a useful function when visually averaging the analogue output of a Sound Level Meter. Its use tends to give the fifty percentile value.

The default setting for this standard shall be the fast time weighting.

Measurement parameter, period and position.

The slow time weighting will always yield a higher $L_{A90\ T}$ value than using a fast time weighting. If there is an impulsive component to the noise then the use of the slow time weighting will result in a significant error.

A regular impulsive noise was recorded on a Nagra tape recorder and figures 3 and 4 show the trace of the variation of sound pressure level versus time with slow and fast time weightings. In fact the trace in figure 3 with a slow time weighting could be deemed to be a "steady" noise which it clearly is not.

4. Measurement period for Background Noise Level

BS4142 states (para 6.1.2) *"Ensure that the measurement time interval is sufficient to obtain a representative value of the background noise level.*

NOTE The measurement time interval is usually at least 5 min."

In the worked examples in the appendix of BS4142 much longer measurement periods were used.

Questions

- ☐ *can percentile level be manipulated.*
- ☐ *why measure for longer than 5 minutes?*

I decided to investigate this using the following procedure.

The dc output of a Sound Level Meter was connected to the A/D input of a computer. A computer program was written so that the computer could determine the instantaneous sound pressure level. The computer sampled the level every tenth of a second and stored the complete distribution of the level together with the Equivalent Continuous Level in one minute blocks of data over a two hour period.

These raw distributions of level were saved to disc. The stored data could subsequently be combined into 5, 10, 15, 20 or 60 minute distributions. These distributions were then processed to yield the (1, 5, 10, 50, 90, 95 & 99) percentile values. In this paper I am essentially only dealing with the 90% value.

In the Calculation of Road Traffic Noise para 4 it defines "the $L_{10\ (18hr)}$ level as the arithmetic average of the L_{10} hourly values for each of the 18 hour periods.

Thus many people are of the misconception that percentiles can be arithmetically averaged. Consider figure 5 where the $L_{A90\ (5min)}$ are 40, 40 & 49 dB whilst the $L_{A90\ (15min)}$ is clearly nearer to 41 dB than any other value. That is there is no way in general of combining percentile values.

So for how long does one need to measure to determine the true background noise level?

The task was to determine a measurement period such that the $L_{A90\ T}$ was quasi static. (The background level will normally have a diurnal variation and thus the background level can rarely be constant over many hours).

In this initial study it has been taken that the hourly values of the background are likely to be stable. Analysis of the moving time average of the percentile values agree with this assumption.

Thus the typical hourly percentile $L_{A90\ (1\ hour)}$ values were calculated.

All the other percentile values were compared to the typical hourly percentile value to determine if a satisfactory value of the background noise level could be determined in a shorter period of time.

Analysis of the results shows that short term measurements of the $L_{A90\ T}$ can lead to significant differences as compared to the typical $L_{A90\ (1hour)}$ value. The shorter measurement of the background noise level will tend to yield higher values than the hourly level.

5. Specific Noise Level

The Specific Noise Level is the noise that is to be rated in terms of an $L_{Aeq\ T}$ (measured over a sufficiently long period to obtain a stable value (if possible) but the measurement period shall not be longer than the reference period).

The measurement period shall include the higher levels of noise.

The Specific Noise Level seems from the questions and comments received not to be understood. Before discussing the measurement period the following comments may be of help:

The Specific Noise level shall not include any significant environmental noise and thus it can and frequently will be considerably less than the Environmental Noise Level for the same location. That is if the specific noise can be heard in the lull in traffic or overflying aircraft or passing

trains or other factory noises or anything else then making a simple measure of the $L_{Aeq\ T}$ including the transportation or other noises will not yield the Specific Noise Level.

It is perfectly acceptable and sensible to measure the specific noise source at times when the environmental noise is at its lowest for example in the middle of the night.

It is permissible to measure the specific noise at times when it will normally not be operating.

One way of understanding what Specific Noise Level we require is to measure the $L_{Aeq\ T}$ for a sufficiently long period of time for the level to stabilise with the rest of the world turned off.

Do the measurement periods for the Specific Noise and Background Noise have to be the same?

— **No.**

— Both shall be measured for a sufficiently long period to obtain a stable level.

Does the equivalent continuous level stabilise quickly and is that value the same as the stable value?

From observations of a sound level meter when switched to measure this then certainly this is true. However I had observed that two similar properly calibrated meters gave different results when their measurement periods were not synchronised.

Thus the computer was programmed to calculate the true $L_{Aeq\ T}$ from the stored 1 minute values. The program could also evaluate the time trend levels over any given time period. This showed that short term measures could yield different values.

The thirty minute values for this site show a high level of stability. Thus the 30 minute value was used to determine for how long a sample had to be determined over to obtain the 30 minute value $\pm$ 0.5 dB. Depending on when the result was calculated from it could take as little as 5 minutes to "stabilise" to as long as 20 minutes. (Though the variation from minute to minute could be small)

Measurement parameter, period and position.

6. Measurement Position

The standard as published does not express clearly what positions should be selected.

At ground floor measure 3.5m from the facade at a height of 1.2 to 1.5m above ground. If there is any other vertical surface or facade then the measurement position shall be at least 3.5m from that surface/facade.

Above ground floor then measure 1m from the facade. If there is any other vertical surface or facade then the measurement position shall be at least 3.5m from that surface/facade.

7. References

1 British Standards Institute BS4142 -1990 Method of rating industrial noise affecting mixed residential and industrial areas.

2 Department of Transport / Welsh Office. The calculation of road traffic noise. June 1988

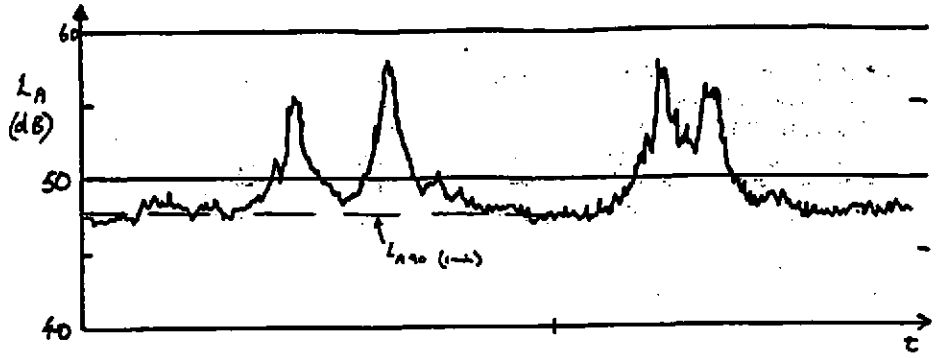

fig 1 Time variation of A weighted level.

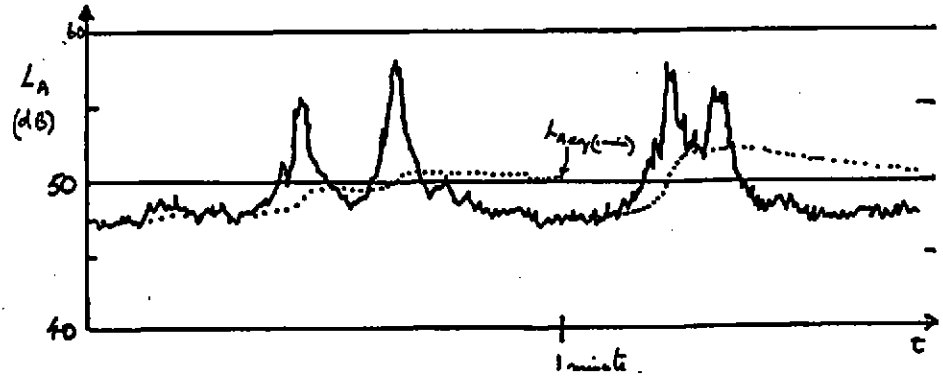

fig 2 Dotted line shows the variation of the equivalent continuous level.

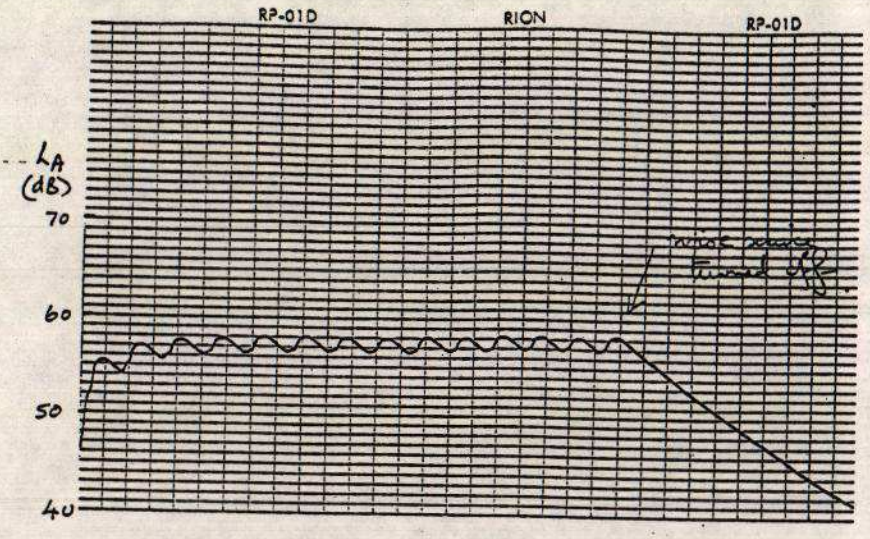

fig 3 Using a slow time weighting.

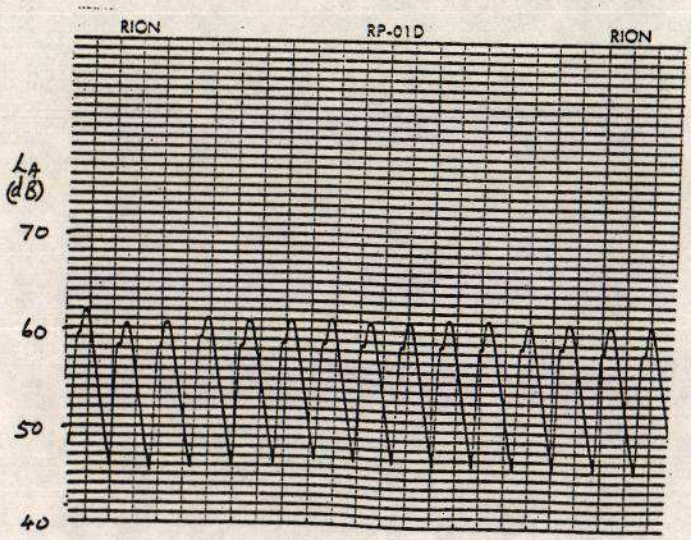

fig 4 Using a fast time weighting.

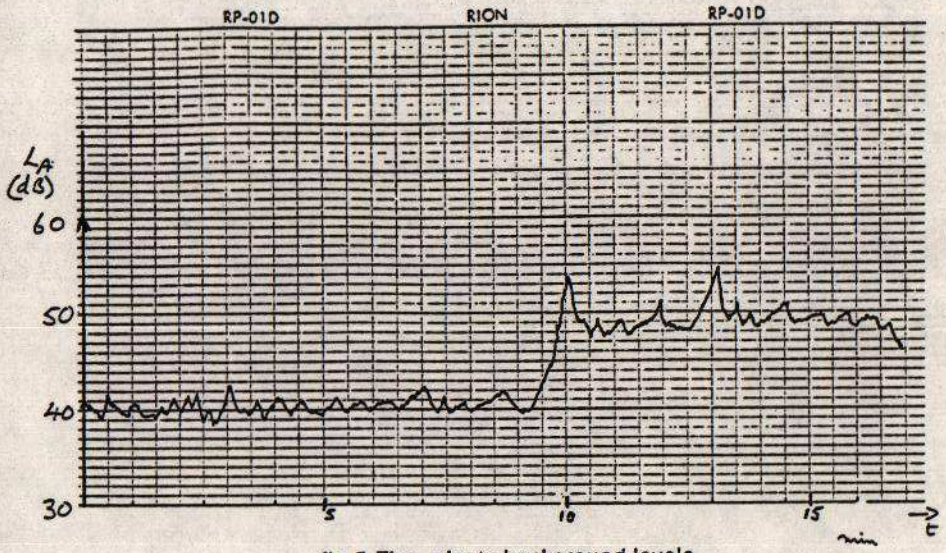

fig 5 Five minute background levels.

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