Proceedings of the Institute of Acoustics

A Proposed New Rating Procedure.

J. Seller

South Bank University, London.

1. Introduction

The current typical assessment procedure is based on the margin by which the intruding noise exceeds the background noise with an appropriate allowance for the character of the noise.

However in certain cases the intruding noise is of a similar or lower level measured in terms of an $L_{Aeq,\,T}$ to the background noise level ($L_{A90,\,T}$ whilst the noise is actually intrusive, audible and causing complaints.
Sometimes there is no significant change in the A-weighted sound pressure level L_{pA} when the intruding source comes on. This does not mean that these descriptors are "wrong" but they cover the complete broadband audio spectrum.
The A-weighted equivalent continuous energy level is a good useful descriptor for many noise sources and the A-weighted background noise level is a reliable descriptor of peoples' subjective impression of the nature of their locality.

The types of noise that I have found difficult in certain situations to assess by the broadband approach are the base beat of disco music and the "rha-rha" of the highly tuned motorcross bike.

2. Currently

Thus there is a choice of fine tuning the corrections for acoustic features or to consider a different measurement technique that has recently become very much easier with the advances made in instrumentation.
A possible solution that I first started to use in 1989 involved comparing the two spectra. One of the intruding noise measured in terms of a L_{eq} against that of the background spectrum measured in terms of an 90 percentile level. In 1989 it took a very long time to determine both spectra with any reasonable degree of accuracy using octave bands because each frequency had to be measured separately for a statistically long enough period. This was normally achieved by the repeated analysis of a tape recording. Third octave analysis of course could have been done but would have taken a great deal of time.
Now technology has developed to such an extent that it is now possible to measure either the A-weighted or linear octave or third octave band levels in a complete range of measurement parameters simultaneously in real time as easily as measuring any broad band parameter.

The ease of measurement of the noise spectra using various parameters has encouraged the application of the comparison of spectra.

Figure 1 shows the linear third octave band $L_{I90,T}$ spectra of the background noise at a location some 300m from the M25. The characteristic two peaks in the spectra can clearly be seen at around 100 and 1 kHz.
There is one disadvantage to linear spectra in that low frequencies are over emphasised with respect to their loudness level. The A-weighting gives a realistic weighting for this level of noise. The derived A-weighted spectrum is shown in figure 2 and the difference between the linear and A-weighted can clearly be seen in figure 3.
In practice there can be a practical advantage in measuring the A-weighted band spectra directly as this tends to be easier to measure than the linear. Particularly with respect to the prevention of overloading the result.

3. Applications using the comparison of spectra.

Case 1
A client wanted to know if motorcycle trials could be conducted on a site without causing noise problems to the residents of the locality. Several motorcycle trials were visited and their noise spectra measured. Figure 4 shows a typical measured source spectrum and an estimated spectrum corrected for distance and the presence of a substantial earth bund: this is then compared with the background level see figure 5.

Case 2
A commercial disco was causing complaints at the nearby residences. The measured disco noise level was only slightly more than the background noise level. The linear spectra of the background and music were measured and figure 6 shows the derived A-weighted spectra. At low frequencies the disco noise was up to 20 dB in excess of the background level.

4. Comment

I was concemed that some of the band levels were very low and that the largest differences between the two spectra were occuring at low frequencies where the 1/3 octave band widths are extremely small. It is well known that the ear has natural bandwidths for as long ago as 1957 Zwicker, Flottorp and Stevens (1) published a paper on Critical bandwidth in loudness summation. Zwicker used this concept in his means for calculating loudness (2) which demanded the calculation of the level in frequencygruppen which for practical purposes are the same as 1/3 octave bands above 280 Hz.
The critical bandwidths as a function of frequency are published in BS ISO 389-4 : 1994 (3) and these are plotted in figure 7. For centre frequencies 315 Hz and above there is reasonable agreement. However below 280 Hz the ear's critical bandwidths are much larger than 1/3 octave bands. Thus these bands should be combined as set out below. Figure 8 shows the combined

1/3 octave bandwidths and critical bandwidths; this shows reasonable agreement. Please note that BS ISO 389-4 does not go below 125 Hz but the bandwidths are very similar to those measured by Zwicker and the critical bandwidth at 63 Hz is take from Zwicker work.

5. New Rating procedure

Thus I propose a new rating procedure which is based on Zwicker's loudness summation procedure and BS 4124 : 1990 (4).

Scope

This procedure is designed for sporting and entertainment noise.

Outline procedure

1) Determine the L_{eq} A-weighted 1/3 octave band levels of the specific noise by either measuring the A-weighted band level directly or by measuring the linear level and subsequently applying the A-weighting correction.

2) Combine logarithmically all the 1/3 octave band levels below 90 Hz (ie up to centre frequency of 80 Hz)

3) Combine the 100, 125 and 160 Hz band levels logarithmically.

4) Combine the 200 and 250 Hz band levels logarithmically.

5) Determine the L_{90} A-weighted 1/3 octave band levels of the background noise and repeat steps 2 to 4 for the background spectra.

6) Compare the band spectra of the specific and background noise.

Rating level

The following features attract a 5dB correction

if the noise contains a continuous note or tone

if the noise contains distinct impulses

Apply ony a *single* 5 dB correction if one or more of the above features are present.

Assessment method

The greater the spectra of the intruding noise is in excess of the background noise the greater the likelihood of complaint.

(1) Zwicker, E., Flottorp, G. & Stevens, S.S. Critical bandwidth in loudness summation J. Acoust. Soc. Am. **29**, 5 1957.

(2) Zwicker, E Ein Verfaheren zur Berechnung der Lautstrake. J. Acoust. Soc. Am. **10**, 304 1960.

(3) British Standards Institute ISO 1994 Acoustics_ Reference zero for the calibration of audiometric equipment_ Part 4 Reference levels for narrow band masking noise. BS ISO 389-4: 1994

(4) British Standards Institute 1990 Method for rating industrial noise affecting residential and industrial areas. BS 4142: 1990

A PROPOSED NEW RATING PROCEDURE.

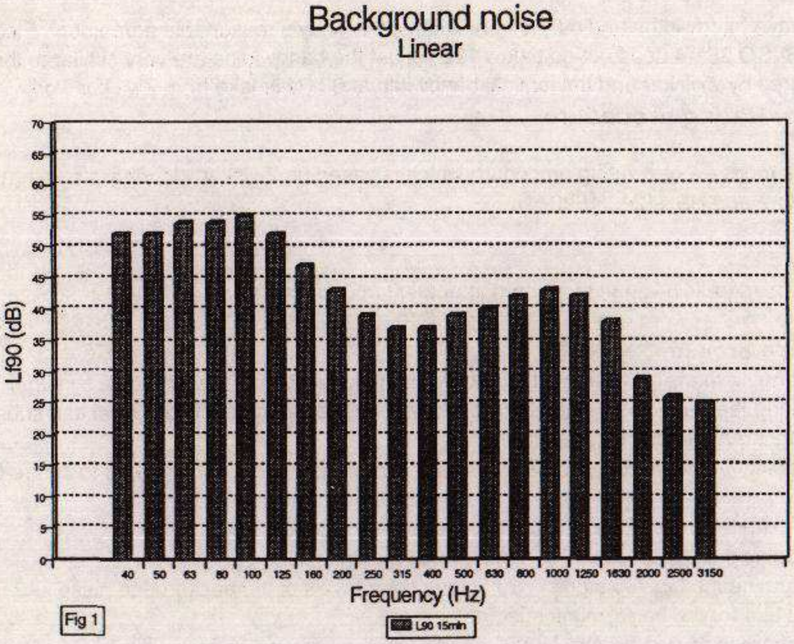

Fig 1

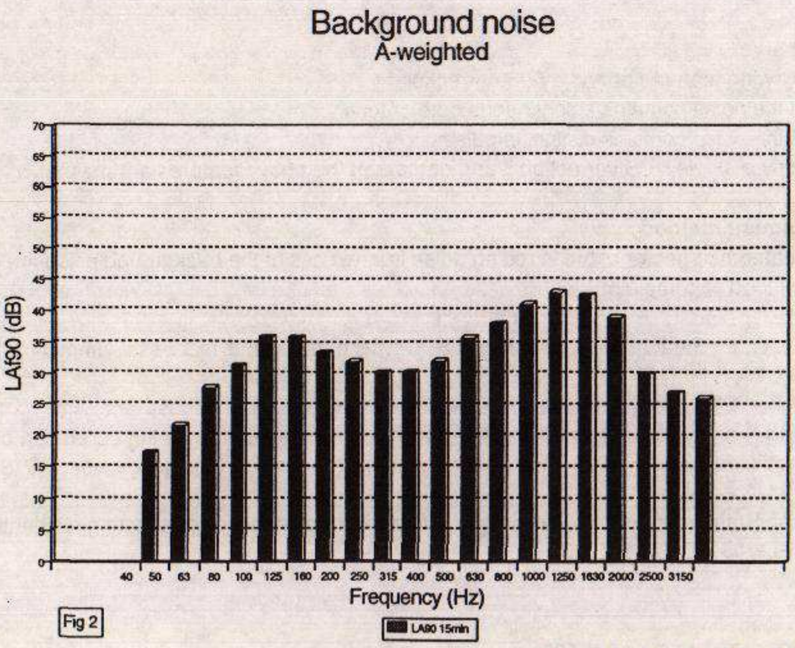

Fig 2

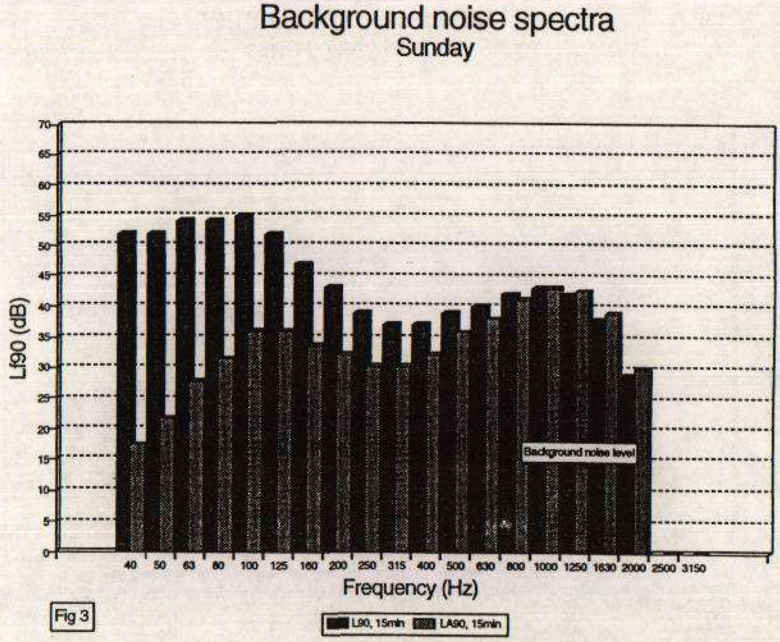
Background noise spectra
Sunday
Lf90 (dB)
Background noise level
Frequency (Hz)
L90, 15min
LA90, 15min

Fig 3

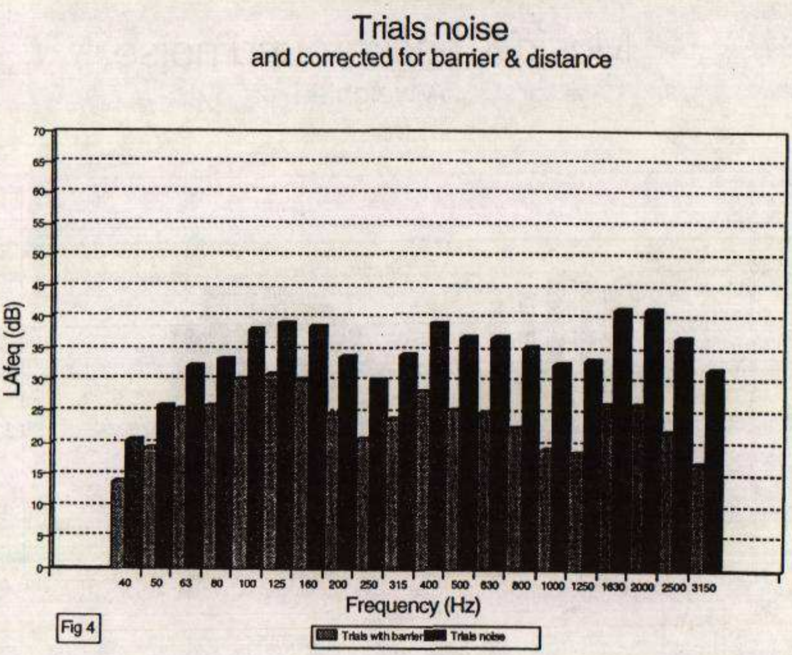
Trials noise
and corrected for barrier & distance
LAfeq (dB)
Frequency (Hz)
Trials with barrier
Trials noise

Fig 4

Trials noise with barrier
and background noise

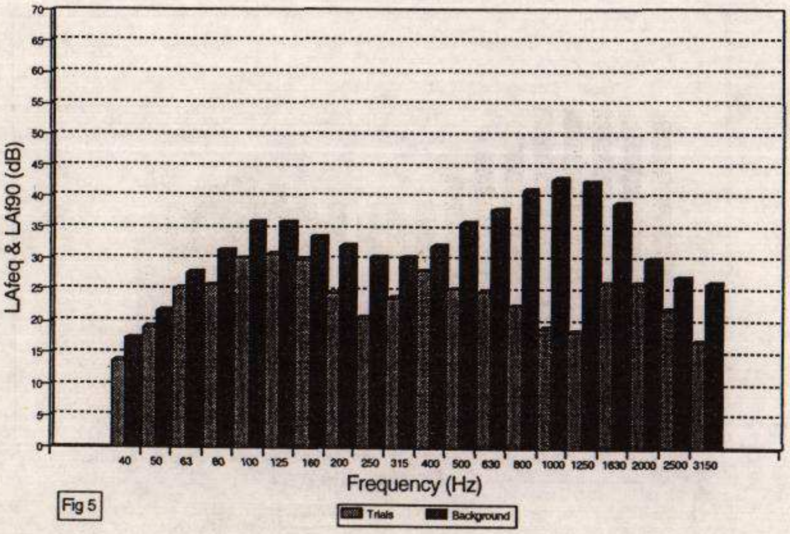

Fig 5

Music & background noise
A-weighted

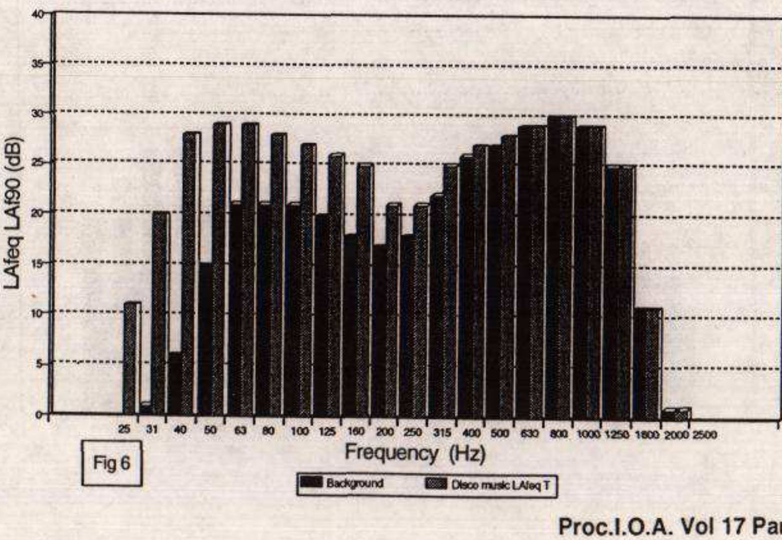

Fig 6

A PROPOSED NEW RATING PROCEDURE.

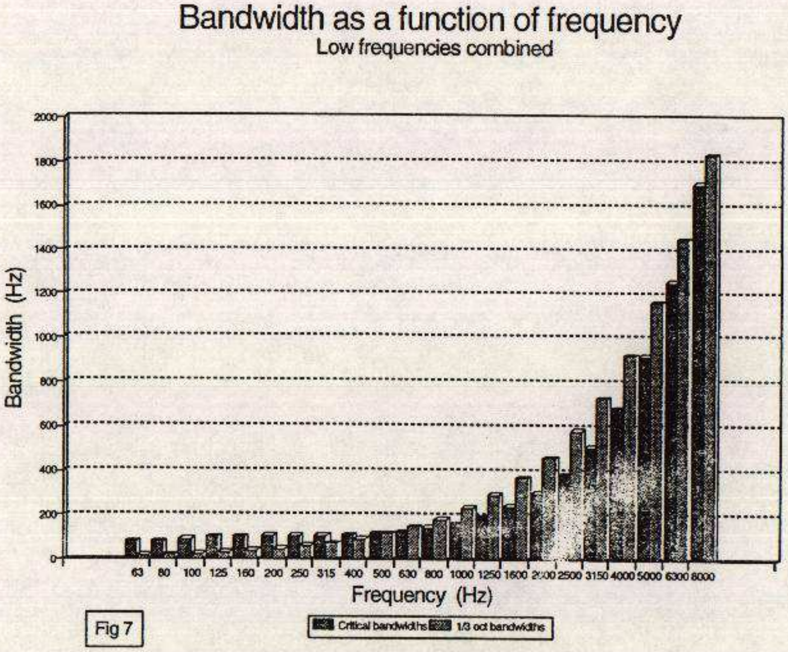

Fig 7

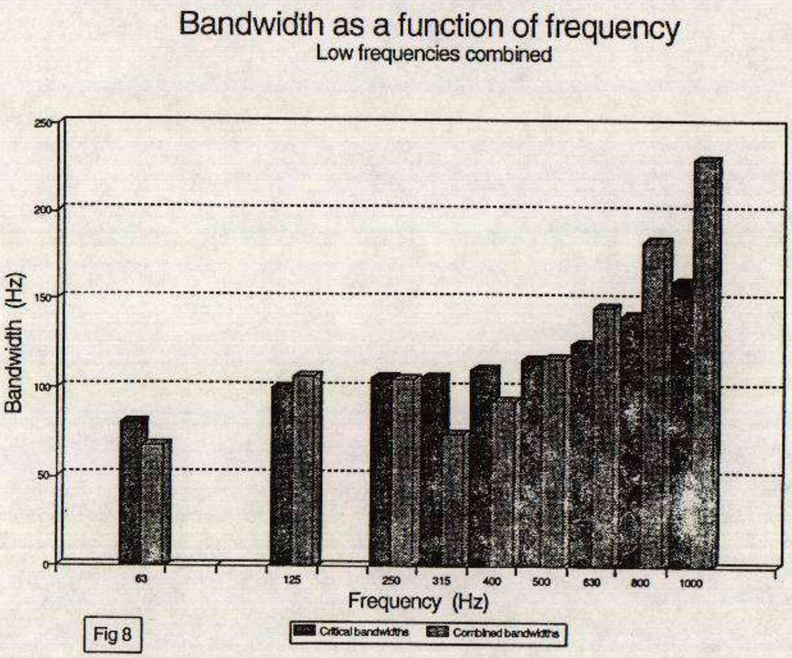

Fig 8