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DIRECTIONAL EFFECTS OF BACKGROUND NOISE MEASUREMENT

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1. INTRODUCTION

Sound level meters have some directional sensitivity, and this means that when measuring noise from a specific source, the meter would normally be pointed towards it, if fitted with a free-field microphone. This has the effect of suppressing the contribution of sounds coming from a high angle of incidence (1). However, there isn't always a specific source, especially in a background noise field. The question then arises whether it matters in which direction the meter is pointed.

Since the rating process of British Standard BS4142:1990 (2), for evaluating industrial noises depends on the availability of a background noise level, against which to compare the rating level, it was decided to investigate.

To achieve this, the Standard recommends the use of Type 2 instruments or better, with Type 1 preferred. Any combination of microphone and meter must have some directional sensitivity, because its presence must disturb the sound field to some extent, and the limits are set out by British Standard BS5969 (3). Table 1, shows the maximum changes in angular sensitivity allowed.

TABLE 1 MAXIMUM ANGULAR SENSITIVITY CHANGE (dB)

	ANGLE	+/- 30°		+/- 90°	
Hz	TYPE	1	2	1	2
31.5-1K		1	2	1.5	2
1K - 2K		1	2	2	2
2K - 4K		1.5	4	4	4
4K - 8K		2.5	9	8	9
8K -12.5K		4	-	16	-

Most meters are fitted with free-field microphones and are

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calibrated in a reference direction equivalent to free-field conditions (perpendicular to the microphone diaphragm, 0°), so accuracy will be greatest if the meter is pointed straight at a specific source. Sounds arriving from a high angle of incidence are liable to be under estimated by a meter with a free-field microphone, particularly if there are higher frequencies involved (1). Conversely, the errors in the low frequency part of the spectrum, for an instrument equipped with a typical 1/2 inch microphone are liable to be negligible. The convention of using A-Weighting, which effectively devalues low frequency components, means that the measurement concentrates more on the high frequencies, and hence possibly introduces directional errors.

Background noise fields may well not feature a predominant specific source. They are more often produced by a large number of incoherent sources, distributed randomly around the observer, and the received intensity is an integration of an angularly uneven incoming field. Its A-Weighted frequency content may consequently introduce errors.

THEORY

The basic assumption was that a background noise field could be modelled by a random field, that is, one where there is equal probability of sound arriving from all directions. It was presumed as well that subjective impressions of background noise are gained by way of a directional average of incoming sounds, the auditory system being directionally sensitive.

It was therefore thought that measurement should proceed by obtaining a directional average.

METHOD

Only L_{Aeq} could be measured by both instruments, so readings had to be taken when noise levels were subjectively rated as uniform, in order to minimise the difference between it and $L_{A}90$.

One meter with a free-field response microphone was pointed N, S, E and W, and then vertically for 3 minutes each, whilst a simultaneous measurement was done with a second meter equipped with a random response microphone set vertically for the whole 15 minutes. Both were Type 1 instruments, and readings were taken at the end of each 3 minutes.

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Locations used were tne author's back garden; an urban industrial area about 300m east of a motorway; a rural village, and an industrial area. Average intensities were computed from the results.

RESULTS

TABLE 2 BACKGROUND NOISE DIRECTIONAL L_{Aeq} (3min)

Period		1	2	3	4	5	MEAN
Garden	Free	46.0	44.4	43.2	46.1	43.1	44.8
	Random	46.7	45.2	44.0	46.5	44.3	45.5
	Difference	0.7	0.8	0.8	0.4	0.8	0.7
Urban Industrial/ 300m Motorway	Free	56.5	52.8	55.8	53.5	54.7	54.9
	Random	56.4	52.7	55.8	53.6	54.4	54.8
	Difference	0.1	0.1	0	0.1	0.3	0.1
Village	Free	46.8	47.8	49.4	39.3	42.8	46.5
	Random	49.8	46.8	49.1	38.8	42.3	47.0
	Difference	3.0	1.0	0.3	0.5	0.5	0.5
Industrial Area	Free	48.9	49.1	49.2	49.2	48.6	49.0
	Random	49.0	49.1	49.3	49.2	48.8	49.1
	Difference	0.1	0	0.1	0	0.2	0.1

DISCUSSION

The differences between the directionally averaged measurements from the free-field system and the time averaged results from the random incidence system were small in comparison to normal measurement repeatability, indicating that background noise fields could be treated as random fields.

In fixed directions the differences between the "Free" and "Random" results were also mostly small, but did approach the order of 1dBA or more in the garden and village situations. It was suspected that this was due to birdsong, which because of its content of fairly high frequencies (around 2KHz) would introduce an effective directionality to the field. A-Weighted spectra comparing a spectrum containing birdsong with an example from an industrial area are shown on the next page.

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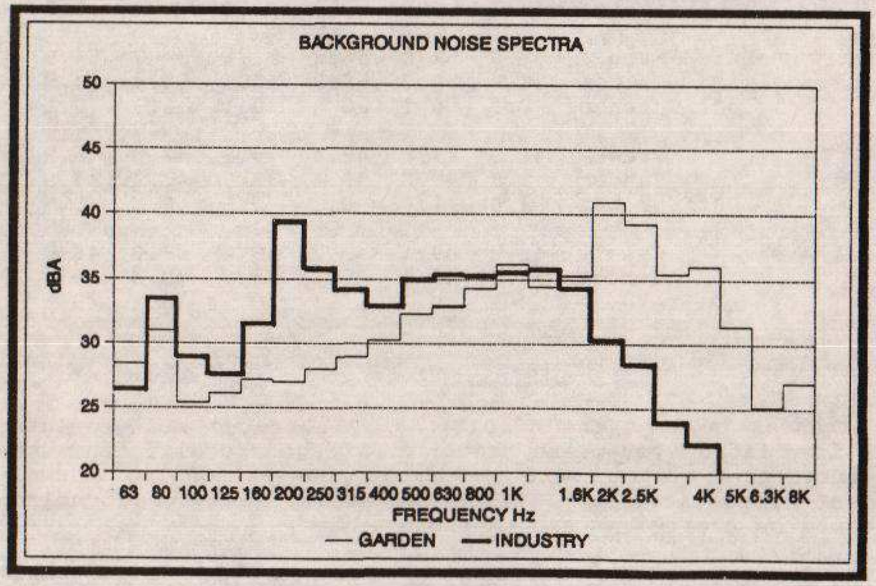
The industrial background noise spectrum was typically not emphasised by high frequencies, so directional measurement errors are small.

FIGURE 1 A-WEIGHTED BACKGROUND NOISE SPECTRA



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CONCLUSION

The results of this investigation were reassuring in that most of the time it did not matter in which direction a noise meter was pointed when measuring background noise. Birdsong could perhaps cause trouble though, in which case two methods of noise measurement could be suggested, either a directionally averaged result, or use of a random incidence microphone correction, with the meter pointing in a vertical direction.

REFERENCES

(1) P V BRUEL "Sound Level Meters - The Atlantic Divide" *Noise Control Engineering Journal* (20) n2 1983.
(2) BRITISH STANDARDS INSTITUTION "BS4142: 1990 "Method For Rating Industrial Noise Affecting Mixed Residential And Industrial Areas".
(3)BRITISH STANDARDS INSTITUTION "BS5969:1981 "Specification For Sound Level Meters".