Proceedings of The Institute of Acoustics

CRITERIA FOR THE ASSESSMENT OF LOW FREQUENCY NOISE

N. BRONER

CHELSEA COLLEGE, LONDON

Introduction

Over the last few years, it has become apparent that annoyance due to low frequency noise sources such as boilers, burners and ventilation systems is more common than originally thought (Anon, 1977; Broner 1978). In most cases, the response of the disturbed individual has been much more extreme than would be expected based on a dBA criterion (Tempest, 1973, Bryan, 1976) and some evidence indicates that this may be due to the unbalanced nature of the spectrum (Kraemer, 1973, Vasudevan and Gordon, 1977). This paper reports some of the results of a psychophysical investigation into the annoyance due to low frequency noise and indicates a superior criterion for its assessment.

Annoyance Response Measurement

The magnitude-estimation technique, in which the subject assigns numbers to quantify his perception, was used. It has been shown that subjects can successfully quantify their sensations for over two dozen continua (S.S. Stevens 1960, 1976, Marks 1974).

Subjects

20 subjects, 10 males and 10 females, participated in the experiment. They were either University staff or post-graduate students and had a mean age of 31 years and a standard deviation of 10.5 years. All reported good hearing and all had no prior experience with the magnitude estimation task.

Stimuli

The noise stimuli consisted of the seven 10 Hz bandwidths between 20-90 Hz and each was presented at an overall sound pressure level of 90, 100 and 105 dB. A sequence for the 21 stimuli thus obtained was generated randomly with the provision that no two adjacent stimuli should be of the same frequency range. The dBA range was 45.8-82.2 dB, whilst it was 68.1-96.8 dB for the dBB noise measure and 46.7-80.7 dB for the dBE measure.

Method

Each subject carried out the estimation task in the Chelsea College low frequency noise test chamber (Leventhall and Hood, 1971). The first stimulus was assigned randomly and then the sequence of 21 stimuli was completed. Each stimulus was presented for 20 seconds with a 10 second break between stimuli (during which the subject responded), resulting in an overall test session length of 10.5 minutes.

Results

The log of the geometric mean of annoyance for the group of 20 subjects as a whole was correlated with each of ten noise measures over the three overall sound pressure levels (see the Table). Figure 1 shows the least squares regression line of best fit for the subjective annoyance against both dBA and dBB, and it can be seen that the spread about the line of best fit is larger for the dBA than for the dBB. This is reflected in the highest correlation coefficient and smaller standard error of the estimate for the dBB measure as shown in the Table. It can also be seen that except for the PNdB measure, every one of the other eight measures yields a higher correlation coefficient than that obtained against the dBA ($r = 0.926$). None of the differences are statistically significant (at $P < .05$ or better) but this may have been due to the small number of subjects employed in this study. As overall the correlation coefficients are very high, greater numbers of subjects may be required to show reliably what appears to be the case - that the PNdB* (the PNdB modified to account for low frequencies) and dBB in particular, gave the highest correlations, (see Broner and Leventhall, 1979).

Conclusion

As there is reason to believe that the dBA measure is not the best predictor for low frequency noise annoyance, it would seem valid to tentatively suggest the PNdB* or dBB as better alternatives. However, as the PNdB* calculation method is relatively laborious, the dBB noise measure, which is widely available on sound level meters, is indicated as the most suitable for general use in predicting the annoyance due to higher level low-frequency noise. The E-weighting, which was recently standardized for use in human response studies, does not seem as useful.

1. Anon 1977. The Sunday Mirror, 19. Have you heard the Hum?

2. N. Broner 1978. J. Sound and Vibration 58(4), 483-500. The Effects of Low Frequency Noise on People - A Review.

3. M. E. Bryan 1976. Infrasound and Low Frequency Vibration (W. Tempest, editor) 65-96. Low Frequency annoyance. London: Academic Press.

4. S. D. Kraemer 1973. M.Sc. Dissertation, Chelsea College, London. Annoyance of low frequency sounds.

5. H. G. Leventhall and R. A. Hood 1971. British Acoustical Soc. Mtg. on "Infrasound and Low Frequency Vibrations" at Salford University 26th Nov. Paper 71.101. Instrumentation for Infrasound.

6. L. E. Marks 1974. Sensory Processes. Academic Press, New York.

7. S. S. Stevens 1960. American Scientist 48, 226-253. The Psychophysics of Sensory Function.

8. S. S. Stevens 1976. Psychophysics - Introduction to Its Perceptual, Neural and Social Prospects. John Wiley and Sons.

9. W. Tempest 1973. Acustica 29, 205-209. Loudness and annoyance due to low frequency sound.

10. R. N. Vasudevan and C. G. Gordon 1977. Applied Acoustics 10, 57-69. Experimental study of annoyance due to low frequency environmental noise.

11. Broner, N., Leventhall, H. G. 1979. A Modified PNdB For Assessment of Low Frequency Noise. To be published.

NOISE MEASURE	CORRELATION COEFFICIENT	STANDARD ERROR
dBA	.926	.097
dBB	.975	.057
dBC	.937	.090
dBD1	.973	.059
dBD2	.969	.064
dBE	.940	.088
PLdB	.941	.087
PNdB (Higgins)	.970	.062
PNdB	.841	.139
PNdB*	.982	.048

TABLE

PEARSON CORRELATION COEFFICIENTS AND STANDARD ERRORS OF THE REGRESSION ESTIMATE AGAINST TEN NOISE MEASURES.

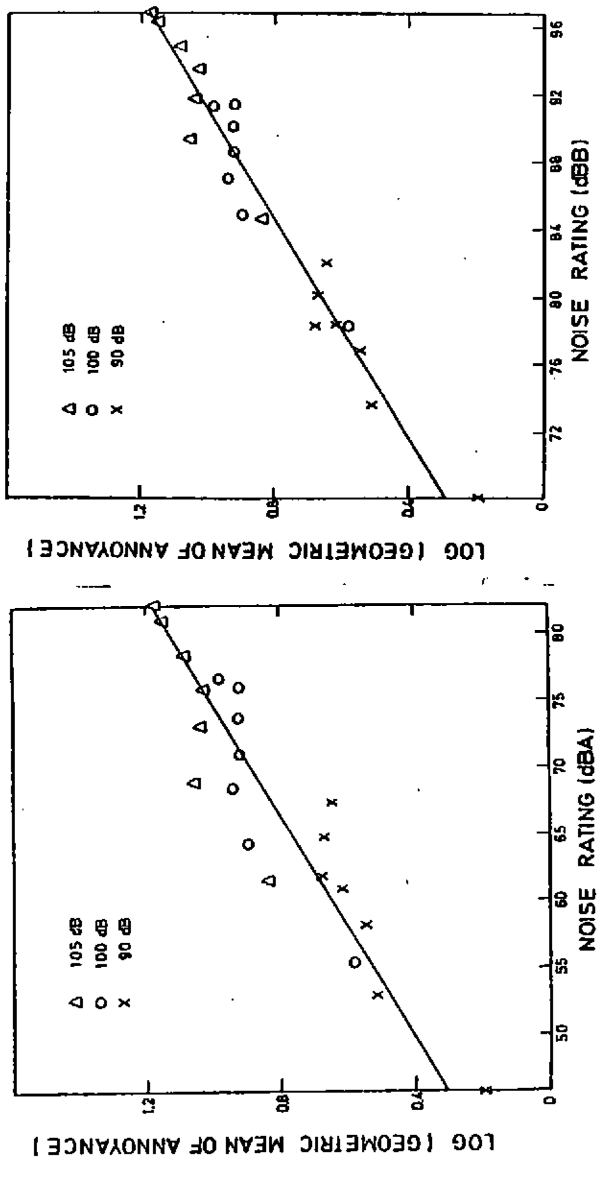

Fig. 1. Annoyance measured by dBA and dBB