Proceedings

LOW FREQUENCY NOISE

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ENVIRONMENTAL LOW FREQUENCY NOISE

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Over the past few years a number of complaints have arisen about environmental low frequency noise. Although inaudible to the casual listener, it appears to be the real cause of severe annoyance to the sufferers. Several common characteristics of these complaints and annoyance situations can be identified as follows:-

(a) The problem seems to arise most frequently in quiet rural or suburban environments. Complaints have been particularly prevalent by people in the 50-70 years age group, although younger people are also affected.

(b) The intrusive noise is often, apparently, so close to inaudibility in level that most people are not able to hear it.

(c) The noise is of a "throbbing" character and is typically audible indoors rather than outdoors.

(d) The noise would appear to be subject to background masking, being more audible at night than during the day.

(e) The complainants have variously described the noise as a "rumbly noise", "the noise of a diesel truck with its engine at idle" and "throbbing noise".

The source of the problem, therefore, would appear to have a low frequency character. This study particularly deals with the frequency range 2-200 Hz.

The work can be split into two parts. (1) A long-term survey and (2) Field measurements.

(1) Survey In order to understand the nature of this mysterious noise problem a random selection of 40 sufferers from Southern England was included in this survey. They were requested to monitor the daily variation of the noise. They rated the noise as being quiet, mild, heavy, very heavy or violent. The survey covered two periods, (i) August-October 1977 (ii) June-October 1978. A typical result is shown in figure 1.

The X-axis represents the hour of the day, Y-axis represents the rating scale and the Z-axis represents the day of the month. The major conclusions arising from this long survey can be summarised as follows:

(i) Between persons, identical rating is not to be expected; individual differences must account for this.

(ii) However, a general trend of daily variation does exist. The noise problem is particularly annoying between late evening and early morning hours.

(iii) 60% of the subjects thought the problem was all the more serious during bad weather or winter months.

In order to distinguish between problems which are imagined or self-generated and those which have their origin in real acoustic phenomena, the complainants were invited to the College to take part in hearing tests. Only eighteen (of the above 40 people) could take part in the hearing tests. These tests form

the subject matter of a companion paper by Walford (ref.1). Participants in the hearing tests also completed a questionnaire. Apart from confirming the general characteristics of the noise referred to earlier, the following points emerged:-

(i) Most sufferers find the intensity is reduced only partially when they close their ears with ear plugs or ear muffs. The noise appears to be subject to masking when the T.V. or radio is on.

(ii) Most sufferers identify the noise as being of a low frequency character. But some thought it contained both low and high frequencies.

(2) Field Measurements Field measurements were made at several locations. A combination of Bruel and Kjaer precision sound level meter (2209) and Real Time Analyser (PARC 4512) was used all the time. In some instances, tape recordings were also made on a SE Lab Eight-Four portable FM tape recorder. These were used for more detailed analysis at a subsequent time. The analysis range was usually restricted to 2 to 200 Hz. The analysis bandwidth was 0.25 Hz. The analysis time was five minutes in each case. This ensured an accuracy of $\pm$ 1 dB with a confidence level of 98%. The system was calibrated before and after each measurement using a pistonphone. Prior to each measurement the electrical noise floor of the measuring system was established by using a dummy microphone. The measurements in every instance showed the electrical floor level to lie well below the recorded acoustic levels.

Figure 2 summarises the result of measurements made at a location in Chiswick. When the noise was heard by the complainant and rated as being heavy, the appearance of a clear peak at 48.8 Hz is noteworthy. In addition, the level itself has risen by 15 dB, bringing it close to the ISO threshold curve (ISO/R226 - 1961).

Figure 3 summarises spectra obtained in a flat in Woking. When the complainant was not troubled by the intrusive noise, outdoor levels below 50 Hz lie well below threshold. However, when the noise was clearly audible to the occupant of the house as well as the experimenter, not only does a clear peak emerge at 40 Hz but also the level rises well above threshold.

All the evidence presented so far suggests that throbbing noise nuisance can be associated with distinct pure tone components. Earlier work by Vasudevan and Gordon (ref.2) at Southampton University does present evidence for also associating throbbing noise situations with spectra which are entirely devoid of any pure tone components - but of an unbalanced spectrum shape, (fig.4). The level of the spectrum changes very substantially from time to time and on the two occasions when the throbbing noise was said to be audible, the spectrum levels lay close to or above the ISO threshold curve.

Where pure tone components have been identifiable, future work must inevitably be directed at locating the offending source. A three element microphone array system mounted on a portable frame is under construction for this purpose. With this, it is hoped that in some instances at least, the mystery behind the throbbing noise will be removed, thus alleviating the annoyance associated with it.

References (1) R. E. Walford I.O.A. Low Frequency Noise Conference January 1979.
(2) R. N. Vasudevan and Colin G. Gordon 1977 Applied Acoustics 10, 57-69. Experimental study of annoyance due to low frequency environmental noise.

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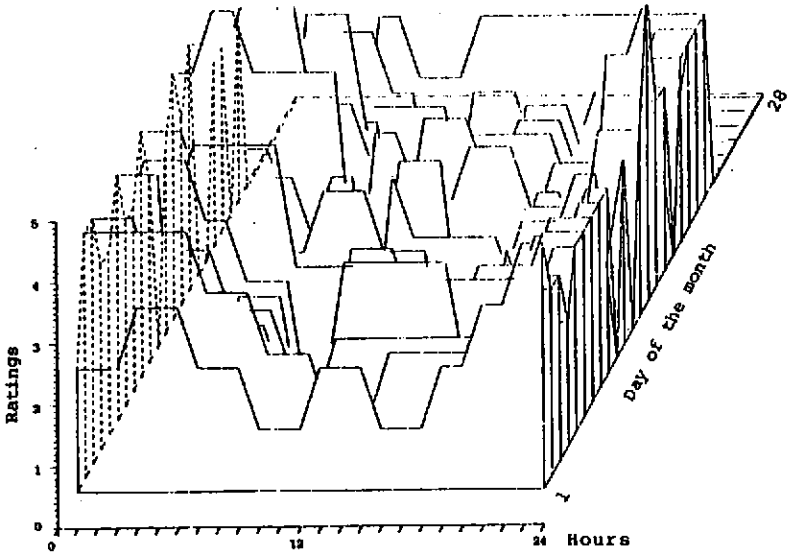

Fig. 1 Diurnal variation during August, 1977.

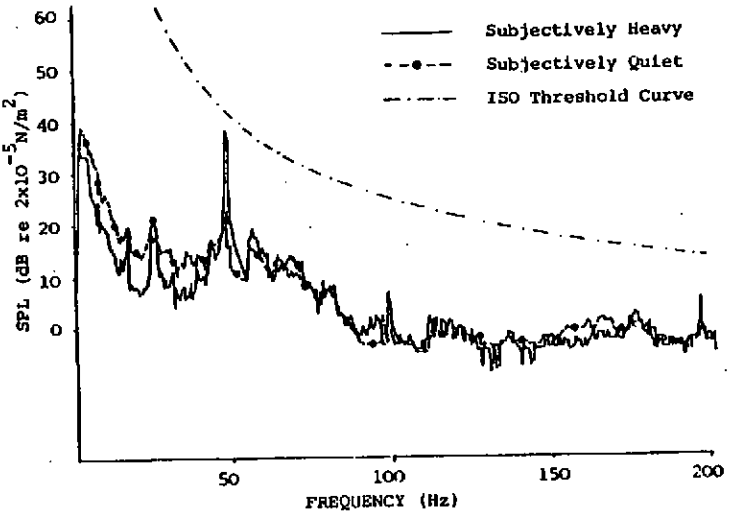

Fig.2 Indoor spectra at a location in Chiswick

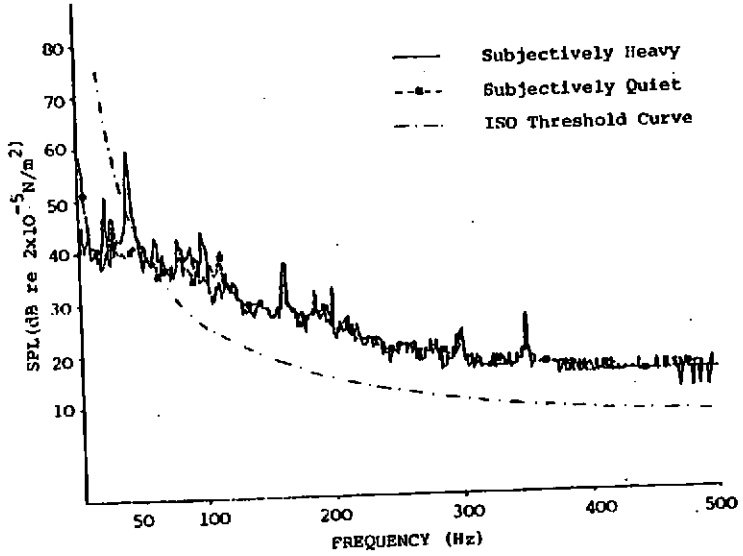

Fig.3 Outdoor spectra at a location in Woking

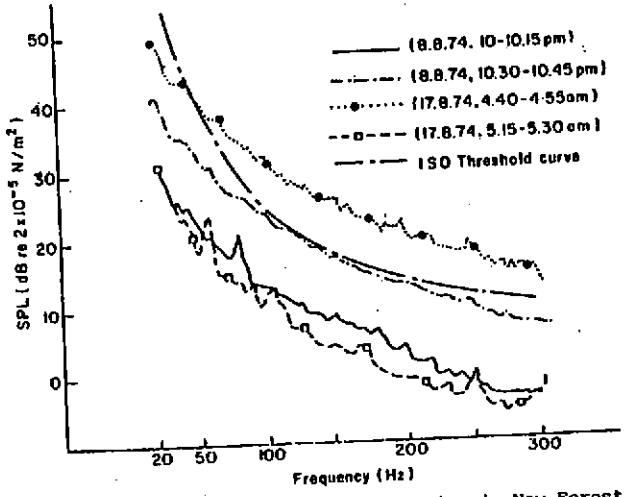

Fig.4 Indoor spectra at a location in New Forest