BRITISH ACOUSTICAL SOCIETY MEETING on 'INFRASOUND': 26th November, 1971 at University of Salford, Lancashire.

"LOW FREQUENCY NOISE AND VIBRATION IN TANKERS"

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The effect of noise and vibration on the personnel of various tankers in the fleet of a large international oil company are being investigated.

A number of voyages have been made on tankers loaded or in ballast during which noise and vibration measurements have been made in the accommodation, public and engine room areas. The objective measurements have been made using a precision sound level meter, which incorporates an octave filter set, and tape recordings of some noise samples were made for subsequent analysis in the laboratory. It was found during the first voyage that there was a predominance of low frequency noise and vibration. In view of this, frequency modulated tape recordings were made which enabled measurements to be made down to 2 Hz. The results of the objective measurements will be discussed as well as the subjective responses of the ships' personnel to the noise and vibration.

There is evidence to suggest that people who are subjected to excessive noise and vibration undergo certain physiological changes. It has been found that under laboratory conditions certain noises produce a pattern of response that is characterised by a decrease in the level of the 17-Ketosteroid group of hormones in urine. Twentyfour-hour urine samples were obtained from volunteers among the ships' officers in order to compare their 17-Ketosteroid levels while on board ship with those levels obtained on leave ashore. The analytical results obtained up to the present certainly show that the levels of noise and vibration are high enough to produce definite physiological changes.

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Annoyance effects due to Low Frequency Sound.

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Introduction

An examination of the literature on the subjective effects infrasound and low frequency sound leaves one in some doubt as to the reliability of some of the work reported. However such work as that being carried out at Chelsea, the National Physical Laboratory Salford, Southampton and for NASA in the United States, is giving us a clearer insight into the effects that sounds in this region have upon humans. There is much work still to be done, for instance we have yet to extend noise criteria down to the infrasonic region. In the last few years an increasing number of noise sources whose energy is predominantly below 100 Hz have appeared, two such are 1) as speeds have increased in transportation (motor vehicles, trains and aeroplanes) and 2) with the increasing use of oil fuel for heating in industry. These new noise sources can give rise to annoyance which cannot always be predicted by our existing methods.

This paper examines, in detail, three cases of industrial noise, predominantly low frequency in nature, where the neighbourhood response was considerably greater that that predicted by existing noise annoyance criteria. I would tentatively like to ask the question are our noise rating proceedures adequate for predicting annoyance when noise sources contain energy predominantly below 100 Hz?.

The Case Histories

Different members of the research group acted as noise consultants on the three noise problems which represent about 5% of the cases dealt with in the last six years. In the remaining cases the energy was above 100 Hz and there was usually good agreement between the criteria (dBA and NR) and the actual public reaction.

Noise (1) Factory boiler, Chester - A large factory had recently converted its central heating boiler, of several million B.T.U's/hr., to oil firing. Two of the four residents who lived 50 yards from the boiler house complained of the new noise which disturbed them particularly in the evenings. As the table shows, outside the complainants' houses the noise level was 55 dBA which was also the maximum permitted level for evenings for that type of area. As the report stated there should certainly have been no serious nuisance which was clearly not the case.

Noise (2) Asphalt plant, Tyldseley - A new plant for making asphalt had opened up at the same time as a development of thirty

bungalows was being completed some 400 yards away. The residents were considerably disturbed by the noise from the 20 million B.T.U/hr. burner of the plant at all times of operation including weekends. They had petitioned the local authority to investigate the noise who had called in members of our group to give an opinion. Despite the fact that the noise gave dBA values of 51-54 outside the bungalows and the permitted values were 55 dBA (daytime) 50 dBA (weekends) and therefore only sporadic complaints might have been expected as many as 50% of the householders were annoyed. The disturbane was considerably greater than the criterion anticipated. In fact the comment made in our report was "both the ISO and the BS 4142 proceedures in our opinion underestimate the problem in this case because of the low frequency nature of the noise". The residents stated that they felt that their houses were being shaken which obviously worried them and we found it was infact possible to feel the windows vibrating.

Noise (3) Ashphalt plant, Heywood - A similar plant to that of noise (2) opened up in an area of established houses. This again caused considerable annoyance in two areas; (3a) of about 150 to 200 terraced houses at about 250 yards from the plant and (3b) in an area of about ten detached houses and bungalows about 500 yards from the plant. It is seen from the table that only at (3a) would sporadic complaints be expected at weekends and at evening working where the actual level exceeds the criteria by 3-5 DB. In practice there were sporadic complaints due to daytime working with widespread complaints due to working at weekends and evenigs. Whilst at (3b) where no complaints were predicted there were complaints due to working at all times. At (3a) thirty two households were interviewed and 47% of these were annoyed by working at weekends and in the evenings.

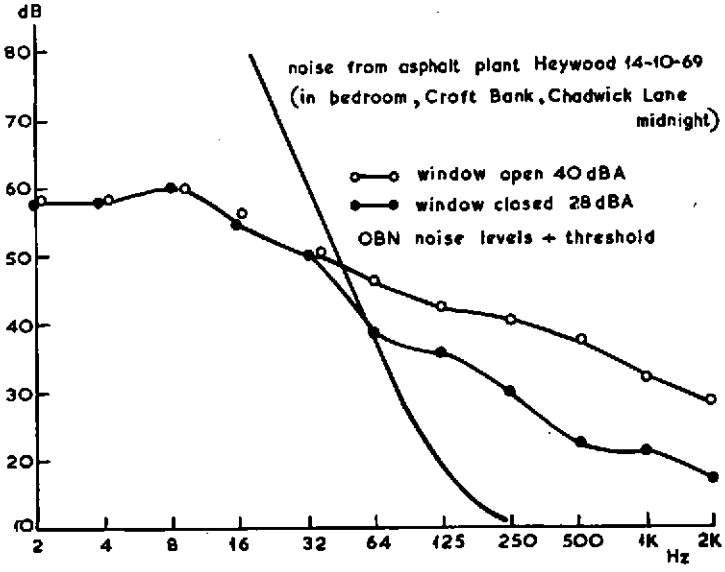
Discussion

It is clear from all three case histories, which are summarised in the table, that the nuisance is rather more severe than the dBA criterion would suggest. The same is true when the NR proceedure is followed. The criteria are, in fact, underestimating the extent of the nuisance by possibly 10-15 dB.

Presumably any explanation of this effect, if only three cases are sufficient to establish it as genuine, must be in terms of the property that they share in common, i.e their energy is mainly concentrated below 100 Hz by the time the noise has reached the residents. This is seen from an examination of their noise spectra only one of which, for the asphalt plant at Heywood (noise (3)), is included in this abstract. This figure shows the noise spectra in the bedroom of one of the compainants at 3(b) down to the 2Hz octave band both for the window open and for the window closed. One interesting fact is that for frequencies below 32-64 Hz the noise level is the same for the two cases. Further despite the fact that there is a difference of 12 dB in the dBA levels for these cases, subjectively the noise level was reduced neither in loudness or annoyance by closing the window.

This suggests that a tentative explanation of the effect may be made in terms of the over-emphasis of the low frequency components of the noise. The higher frequency components are attenuated more by distance and transmission into the houses, whilst the former frequencies are little affected. This leaves, in all three cases, noise spectra in the houses with slopes of around 10 dB / octave. In these circumstances NR and dBA, with their reduced emphasis of low frequencies, seem inappropriate in predicting

annoyance. Also for some reason, as yet unexplained, this type of noise is particularly annoying. Possibly this annoyance may be related to unease of an unusual sound and one which is not masked by normal household activity.



TABLE

No	Noise Source	Area	Noise Level-dBA		Expected Reaction	Actual Reaction	Residents Aa.		Noise Spectron at houses	Distance noise-Residents yards.
			Actual	Permitted			Number	%		
1	Factory Boiler	Chester	55	60+ 55*	No complaints	Complaints	2	50	falling with frequency, peak 63Hz	50
2	Asphalt plant	Tyldseley	51-54	55+ 50‡	No complaints Sporadic complaints	complaints all times, vigorous action	15	50	falling with frequency	400
3a	Asphalt plant (1)	Heywood	53-55	55+ 50*‡	No complaints Sporadic complaints	Sporadic complaints Widespread complaints	15**	47	falling with frequency	250
3b	Asphalt plant (2)	Heywood	51	55+ 50*‡	No complaints No complaints	Complaints all times	2	20	falling with frequency	500

\+ daytime 8 a.m - 6 p.m
* Evenings up to 10 a.m
‡ Weekends
** only 32 households visited, probably about 150 inarea. - 200.