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A STUDY OF ENVIRONMENTAL LOW FREQUENCY NOISE COMPLAINTS

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1. INTRODUCTION

In the early 1970's many reports appeared in the press referring to "hums", "mystery noises", "low frequency sound" etc.

There was the well known "Bristol hum" which was ultimately attributed to a large factory fan. There were other reports of complaints about domestic oil fired heating boilers and supermarket refrigeration plants.

At one period in the 70's some credence was given to the idea that there might be a very widespread hum problem affecting people in various parts of the country. This was given national coverage in 1977 when the Sunday Mirror asked its readers "Have You Heard The HUM?" and received 768 replies. However none of the subsequent investigations, to date, have revealed that there is or ever has been a "National Hum", although speculation that the national gas grid produces widespread low frequency noise is still popular among some complainants. Evidence shows that complaints about low frequency noise come from all over the country and the sources that have been found are many.

The Department of the Environment has received a small but steady flow of complaints about Low Frequency Noise for many years and in 1988 they funded a review of the disturbance caused by Low Frequency Noise which included a survey of the complaints received by Local Authorities. From this survey it was estimated that complaints to Local Authorities were received at the rate of about 500 per year in total and positive identification of the source causing the complaint was made in slightly less than 90% of cases. Conversely only about 10% of cases proved too difficult to solve.

In 1992 a research contract, under the direction of the Building Research Establishment, was placed with Sound Research Laboratories (SRL) to investigate some of the unsolved cases and as a result of the experience gained provide practical guidance for those professionals who have to deal with similar problems. Sound Research Laboratories sub-contracted audiological studies on a sample of the complainants to the Audiological Unit, Addenbrookes Hospital.

2. OBJECTIVE

The proposed programme of work was to obtain a list of low frequency noise complainants with brief details of the history of their complaint. From this list to pick 25 cases for detailed investigation. By carrying out site

investigations on these cases develop techniques to detect the low frequency noise causing the problem and then to locate the source. The programme also included audiological investigations on a sample of the complainants from these cases to ascertain any audiological effects that may be contributing to the noise problem experienced by the complainants.

3. THE STUDY SAMPLE

This research has received publicity by the Low Frequency Noise Sufferers Association (LFNSA), in the press and radio at a local, national and international level.

Environmental Health Officers were canvassed to ask them for details of cases they received.

Contact was established with over 380 complainants. Some of these were people that contacted Sound Research Laboratories (SRL), the Building Research Establishment (BRE) or the Department of the Environment directly as a result of the publicity. However the majority were referred by Environmental Health Officers (EHOs) who had first investigated the complaint.

A simple questionnaire was produced to gather the relevant information on each case in a consistent format which could be easily accessed. The questions covered personal details about the complainant, details about the noise causing the complaint and details about the sufferers residence and surrounding area.

4. SUMMARY OF INFORMATION FROM COMPLAINANTS

A total of 385 questionnaires were sent out during the project and of these 273 were returned completed, a return rate of 71%. These numbers cannot in anyway be used to indicate the number of sufferers in the country.

A total of 295 sufferers were listed in the 273 questionnaires. Of the sufferers 111 were male and 184 female, that is, 38% male and 62% female.

The distribution of the age range of sufferers is shown in fig. 1. It can be seen that in this sample of sufferers the distribution of female sufferers with age rises steadily to a peak in the age range 60 to 70 of 36% and then falls rapidly. Whereas in the distribution of males there is very little difference between the age ranges 40 to 50 (29%), 50 to 60 (28%) and 60 to 70 (25%).

The most common descriptions of the noise use the words "droning, distant plane, lorry, diesel engine, generator and motor hum". Other words used are "turbine, whine, high pitched sissing, whistle and hissing". Some descriptions use a number of these words. In a few cases the sufferers have said it is too difficult to describe.

Complainants that have returned details live in all regions of England, in Wales and in Scotland. There also have been details received from complainants living in the Channel Islands and the Isle of Wight.

5. SELECTION OF SAMPLE FOR INVESTIGATION

The sample for site investigation was chosen using information in questionnaire data. The sample includes male and female complainants; cases in rural and urban areas. Cases were chosen in various geographical areas from the south coast of England to Ayrshire in Scotland and from Bristol in the west of England to Ipswich in the East. As the work progressed investigations were concentrated on cases where more than one person in the same household were reported to hear the noise. Cases where, from details given, the complainant was suspected of suffering from tinnitus were not included in the sample.

6. SITE INVESTIGATION METHOD

As one of the aims of the project was to develop a method for the investigation of low frequency noise complaints this method evolved through experience gained during the investigations.

Generally investigations were conducted within the sufferer's property, as this was the place were the noise was heard. The investigations would normally be made in the evening and sometimes into the early hours of the morning, as the noise was usually either not heard or said to be less noticeable during the daytime. As far as possible measurements were carried out on relatively calm days.

The outline of the investigation procedure was as follows:-

i) Initial interview with sufferer.
ii) Investigator listens for noise.
iii) Tests, such as tone matching, to try to establish more about the nature of the noise heard.
iv) Measurements of the ambient noise levels to try to identify the specific noise causing the noise nuisance. Narrow band (1/24th octave) real time analysis was normally used however in some cases an FFT (Fast Fourier Transform) Analyser was used.

The initial interview was used to confirm details given on the questionnaire and for the sufferer to add further details, to describe the noise including its current audibility and to give the investigator an idea of what to look for.

The investigator listened for the noise with the complainant at the places in the residence where the complainant said they could hear the noise.

Tone matching was developed so that the investigator could try to get an approximate idea of the frequency of the perceived noise and the sufferer's

subjective impression of the level of the noise. This was considered to be especially necessary in cases where the investigator could not hear any specific noise.
Tones derived from a signal generator were played to the sufferer through a loudspeaker. Various tones of higher and lower frequency were played and the sufferer was asked to indicate whether each tone was higher or lower than their perceived noise. Gradually the tone was brought to the same frequency as the perceived noise. To start with, the amplitude of the sound was kept clearly audible to both the sufferer and the investigator. If the frequency of the perceived noise could be established an attempt was made to adjust the sound level until it matched the level of the perceived noise. In some cases the minimum level at which the sufferer could hear the tone frequency was also established.

During the tone matching the frequency and level were monitored with a real time frequency analyser using a microphone near the ear of the sufferer. Details of the frequency and tone levels were noted from readings on the analyser. If two sufferers were in the same residence, the tone matching was done independently in order that one sufferer did not influence the other.

It should be pointed out that tone matching can be misleading due to the likelihood of octave confusion and other factors associated with these tests. In many cases the pure tone was said to sound completely different from the perceived noise. Other noises such as beating tones and bands of broadband noise were tried in some of these cases but these also failed to produce matching sounds.

To carry out a measurement of the ambient noise in order to detect the perceived noise, the microphone was normally placed at the position where the sufferer considered the noise to be most noticeable. The frequency spectrum was closely observed to see whether or not any specific noise could be detected which related in any way to the description of the sufferer's perceived noise. The whole frequency range was studied even if the perceived noise had been matched to a specific tone frequency by the sufferer. The analyser was normally set to have a lower limiting frequency of 0.7 Hz. The real time analyser was initially used in "free run" mode (exponential averaging) with an averaging time of 1/4 sec. This technique allowed any modulation, "beating" at a particular frequency to be observed. This was considered important, because a number of sufferers had described a noise like a twin engined propeller aircraft, which did not have the propellers synchronised - a classical "beating" phenomenon.

7. SUMMARY OF INVESTIGATIONS

Of the 26 cases investigated by SRL under the contract there were only three cases where the noise could be positively detected by measurement and/or audible to the investigator. In two cases the noise complained of was consistent with the 100 Hz noise emitted by electrical sub-stations nearby. In the other case there was a narrow band of measured noise centred on 104 Hz which although at a low level was audible to the investigator. This noise spectrum is shown in

fig.2. The noise in this case was not audible or detectible outside the house.

There are another seven cases where, for a variety of reasons, there is evidence to suggest that with much longer term noise measurement it may be possible to detect the noise causing the problem. In most of these cases it is suspected that the sufferer has been sensitised to the noise at some time in the past when it was louder and more continuous than now. In one of these cases the noise was identified by the sufferer outside in a nearby street, it was detected by measurement, the measured noise spectrum can be seen in figure 3. The 270Hz noise was identified as coming from a distant factory, however, it was not possible to measure the noise in the complainant's residence. It is known that the noise from this factory has been reduced and although previously disturbing a number of surrounding house occupants now only affects the complainant who still hears the noise almost continuously.

SRL have investigated two additional cases for other clients and with the permission of those clients included details of these investigations in this study. In both these cases there was little doubt that the source of the noise was from industrial machinery or plant, measurements being used to confirm the cause and to provide information on which to base recommendations.

Towards the end of the project BRE carried out another five investigations testing the methods established by SRL. In none of these cases was a noise level measured in the complainant's residence that related to the noise they described. In one case it seemed possible that the complainant had experienced low level industrial type noise within his home from a water pumping station and this may have sensitised him to low frequency noise. In the other cases although low level low frequency noise was present in the residences it did not relate to what the complainant experienced either because when the measured noise ceased the complainant could still hear a noise or the complainant complained of the noise being loudest in rooms where no specific low frequency noise could be measured above the general background.

8. SUMMARY OF AUDIOLOGICAL FINDINGS

The Audiology Department of Addenbrooke's Hospital were asked to perform audiological investigations on a small number of participants in the study. As it became apparent that the majority of cases were those in which no noise corresponding to the complaint could be identified, the significance of the audiological findings increased.

Comprehensive audiological testing was undertaken of ten complainants and in two cases of non-complaining spouse or family member.

True hyperacusis, being hypersensitivity and annoyance from all sounds, was indicated in one case, but an additional three showed specific hypersensitivity to the noise of their complaint.

Three complainants were considered to be suffering from tinnitus. In one of these cases the wife was the principal complainant, and on hearing the noise of complaint clearly in a sound proof room was said to have tinnitus. The husband was also a complainant, but had normal hearing and was unable to hear the sound in the sound proof room. The conclusion was made that his wife's complaint had drawn the husband's attention to low frequency sound in the environment, and so he had become convinced of the complaint and shared the distress. A second case was similar to this but since in this case the wife only had a mild tinnitus the possibility of a noise relating to the complaint being present could not be ruled out.

In one case there was strong evidence that a noise was indeed present as the noise was heard by the whole family, and only in one bedroom, and indeed measurements within the home identified the presence of a noise relating to the complaint.

9. CONCLUSIONS

Complaints about low frequency noise have occurred for many years and have been referred to both Local Authorities and Central Government. The latter usually being referred to when the complainant failed to get a satisfactory outcome to their complaint to the former.

Some sufferers of low frequency noise believe that there is a national source of low frequency noise, such as gas pipelines. This study has failed to find any evidence of a national source of low frequency noise.

This project was started with the aim of developing simple measurement techniques that acoustic professionals could use to establish the cause of low frequency noise complaints and to locate the source. The measurement procedure that evolved during the project used a portable 1/24th octave analyser to display the noise spectrum in real-time while the complainant indicated or described the characteristics of the noise they were hearing. A loudspeaker and signal generator were also used to play tones to the complainant to attempt to match the frequency of the offending noise.

In most of the cases investigated it was not possible to find noise having characteristics which related to that complained of by the sufferer. Audiological investigations indicated that in some of these cases the complainant had a hypersensitivity to the noise about which they were complaining. In a few cases the audiological investigations indicated that the complainant was suffering from tinnitus and that this was the likely cause of the complaint.

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FIGURE 1. Age Range of Sufferers

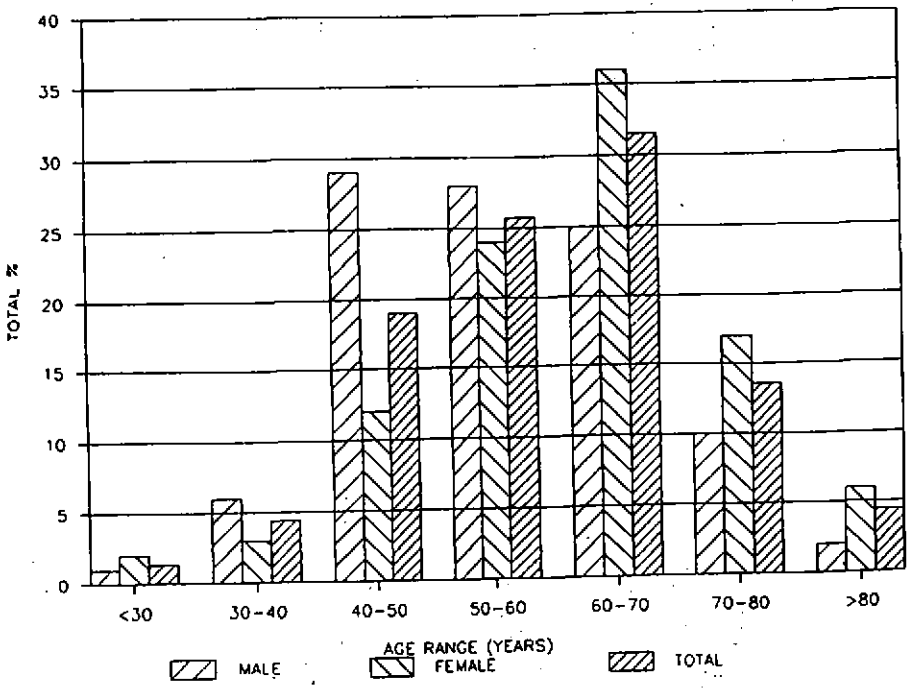

FIGURE 2. Noise Spectrum Inside Bedroom

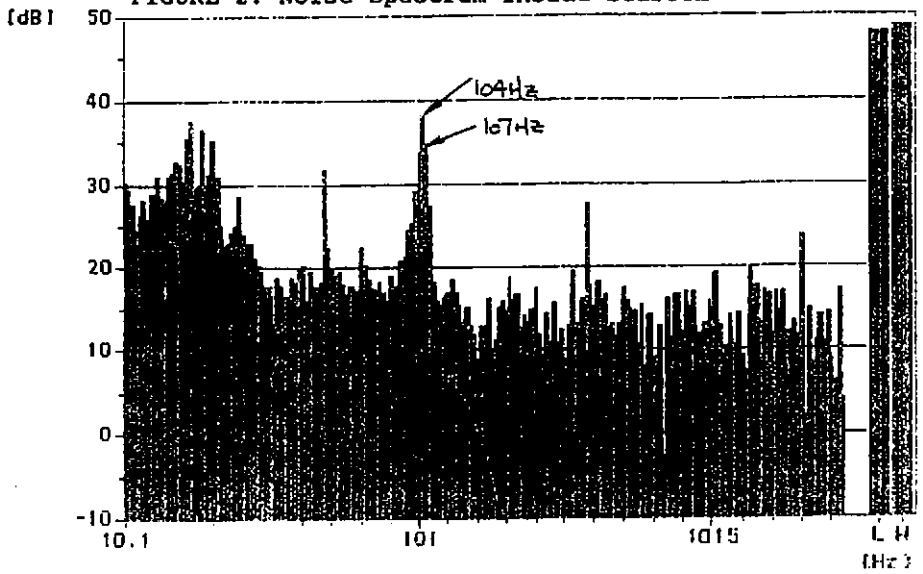

FIGURE 3. Noise Spectrum Outside in a Nearby Street