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URBAN NOISE MEASUREMENT AND EVALUATION

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During the last few years there has been a marked, although rather belated upsurge in interest in the protection of the environment from all forms of pollution including noise. The World Health Organisation has defined health as:- 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'
On this basis although noise cannot be said to cause any physical or physiological damage to the average citizen in his home or on the street, the health of many thousands of people, particularly in the so called developed countries is clearly affected.
Great Britain was one of the first countries to recognise the importance of noise and in 1963 the Government published a Report on Noise by a Committee headed by Sir Alan Wilson. The Wilson Report was a very valuable document from the point of view of summarising the problem and suggesting future legislation, but it was not very specific in suggesting numerical noise limits or standards, except in the case of noise emission from motor vehicles. Following the publication of the report, little was done to implement its findings except as regards a very modified form of noise emission tests for motor vehicles (1), and the introduction of a grant scheme for residents living near Heathrow Airport (2). At a national level, the question of environmental standards for housing was left in abeyance for almost ten years, but in the Greater London Council, the tentative recommendations in the Wilson Report were adopted (3) as desirable standards for all new housing schemes.
Apart from this the first concrete proposals for environmental noise standards were put forward by the Noise Advisory Council who recommended that 'in no circumstances should existing residential development be subjected, as an act of conscious public policy, to L_{10} levels in excess of 70dBA unless some form of remedial or compensatory action is taken by the responsible authority'. They also stressed that 'an L_{10} level of 70dBA constitutes, in our view, the limit of the acceptable rather than a standard of what is desirable. Wherever possible, planners should design to lower levels'. L_{10} is normally defined as the noise level exceeded for 10% of the time, but in this proposal it was further defined as being the arithmetic average of the 18 hourly L_{10} levels between 0600 and 2400 on a normal week-day, as existing one metre outside the window of a dwelling. This proposal was quoted in Parliament in June 1971 (5) and was then taken up in the Report of the Urban Motorways Committee in the following year (6). This Committee expressed reservations 'with a limit which on present evidence, only just avoids a majority of people being dissatisfied, and we would prefer to see a lower level'.
The UMC Report went into some detail in describing methods of minimising noise nuisance due to new roads by first selecting appropriate routes and secondly by the design of the road itself. The financial implications

of these measures were also discussed and it was suggested that the overall cost of implementing the recommendations would be of the order of £30-40,000,000 per year. The views of the Urban Motorways Committee were broadly accepted by the Government (7) and in January 1973 an important circular was published entitled 'Planning and Noise' (8) which incorporated the UMC views. This circular also covered aircraft and industrial noise, and with respect to the former recommended the establishment of development control zones near airports, based on the Noise and Number Index. Guidance was also given on criteria for noise from industry, expressed in Corrected Noise Levels (as set out in British Standards 4142 (9)).

Up to this stage, the Government publications had been in the form of guidelines and recommendations but, except as possible supporting evidence at Public Inquiries, they had no legal validity. Legal powers were first contained in the Land Compensation Act of July 1973 and the related Regulations (10) which came into force on 1 September. These documents have, we feel, changed the whole concept of planning against noise in Britain and affect us both as regards the powers now available, and the new techniques of measurement and predictions which will be required to implement them.

The Land Compensation Act specifies the conditions under which highway authorities are either empowered to or obliged to pay compensation for disturbance caused by new or altered roads. Very broadly compensation will be payable in cases where a new road is built or an existing road is widened, and the environment consequently deteriorates. In extreme cases the Act sets out the conditions under which property may be acquired by the highway authority and the basis on which compensation is payable not only for the value of the property but also the disturbance caused to the occupiers. Another important section covers the provision of sound insulation in cases where it can be shown that the noise level due to the new road is increased and that the increased level exceeds a specified figure. It is this section which we believe will have the greatest effect over the next few years and we would like to discuss this in some detail.

The Regulations describe the 'specified level' as being an external L10 of 68dBA, this figure being defined as the arithmetic mean of the 18 hourly L10 figures between 0600 and 2400 hours. Where the new or realigned road causes an increase of at least 1dBA, and the specified level is exceeded, the highway authority 'may' or 'shall' provide sound insulation for the dwellings affected either by arranging for the work to be carried out directly, or paying the occupier to have the work done. In cases where the road is new or a new carriageway has been built, and the road or carriageway was first used after 16 October 1972 and highway authority is obliged to take remedial action, but if the road was first used between 17 October 1969 and 16 October 1972, or if the alteration is simply a widening rather than the provision of the new carriageway, the highway authority is merely empowered to take action. In any case, if sound insulation is provided it has to meet the stringent specifications laid down in the schedule. Although these Regulations are to be welcomed as being a major step forward in alleviating noise disturbance, there are a number of shortcomings. These are:- 1. The single 18 hour period does not differentiate between environmental requirements for day and evening. 2. The basis for the original 70dBA level and the 18 hour period is a survey at only 11 sites, all on main roads and with residents used to traffic noise. 3. The level of 68dBA externally is 18dBA higher than the Wilson night-time recommendation for busy urban areas (35dBA internally, plus 15dBA for slightly open windows). 4. By specifying an external standard, no indication is given as to the degree of insulation required, and this cannot be varied for different room uses. 5. The insulation specified is the same irrespective of the degree by which the level is exceeded. 6. The predictions (12) take insufficient account of heavy vehicles. On urban roads (as opposed to

motorways) the percentage of heavy vehicles is more critical than the volume (13). 7. There are practical difficulties in carrying out 18 hour continuous recordings, especially if these have to be attended throughout the period.

It appears that basically there are four methods which could be used to take the 18 hour recordings as specified in the Regulations. These are:- 1. The conventional method with microphone amplifier, level recorder and statistical distribution analyser. This requires continuous attendance and readings are taken hourly. (14). 2. As above, but unattended and the analyser is photographed at hourly intervals. A tape-recorder can be used to monitor the audio-signal for, say 10% of the time. 3. A sound level meter with obscuring device is read for 15 minutes in every hour by an observer (15). 4. Noise level sampling on to data logging equipment. It is the fourth alternative which at present seems most promising and which will be briefly discussed.

This involves amplifying the signal from a microphone and converting it to a d.c. level. The voltage obtained is on a logarithmic scale, and in order to obtain a voltage that is directly proportional to the noise level in dB, it is also necessary to record the d.c. voltage logarithmically. This gives a greater dynamic range of the measured noise level. The signal is sampled, and an analogue-digital converter gives a binary signal that can be transferred on to a digital recorder. The tape so obtained is then replayed on a central analysis system and any parameter such as L10 or Leq can be determined over various time periods.

The analysis system starts with a cassette translator, followed by interfacing to one of four peripherals; these can be a paper tape punch or computer compatible tape recorder, or a programmable calculating machine, or direct to a computer. The first two methods involve subsequent analysis of the paper or magnetic tape by computer; this is an ideal off-line means of fairly rapid processing but delays can occur while waiting for computer time. The third method of using a programmable calculator is probably the best in situations where no computer is available and the fourth method of on-line computer analysis is the fastest.

The first commercially available equipment investigated seemed to be ideal, comprising a complete system built into one box. The logger needed a conventional condenser microphone and sampled at a rate of between once every half second and once every four seconds. Eighteen hours continuous recording was possible at the half-second rate. The voltage to the recorder was divided into 100 segments giving readings accurate to about 0.5 dB. The microphone preamplifier was described as precision grade and comparative readings taken alongside the conventional system agreed fairly well. It was either mains or battery powered and would cost about £1200. The second system comprised a small battery operated data logger connected to a special amplifier which incorporated a logarithmic d.c. output. This system was chosen for experimental trials as facilities were already available for processing the cassettes and the microphone amplifier was in any case useful for conventional noise measurement. The voltage on the recorder was in 240 segments giving a resolution of about 0.2 dB. This meant that more space was required on the cassette for recording the digital information but it was possible to record 18 hours continuous sampling once every second. The total system however, cost about £1600 but this could have been obtained for about £1150 by use of a cheaper amplifier. The third system currently being considered consists of a very small analogue tape recorder which has a frequency response of 0-10 Hz. The logarithmic d.c. level is recorded directly on to the cassette which will run continuously for 18 hours. On replay the tape speed is increased by a factor of 60 and an analysis system samples the signal at a rate equivalent to once per second and gives direct read-out of L.10, L.50 and L.90. The complete logging system of amplifier and recorder can be obtained for about £850 and the analysis equipment for about £2000. The overall accuracy is claimed to be plus or minus 1 dB. Although untried, this system appears to have

two main advantages. Firstly, a chart recording could be obtained from the cassette by means of an ultra-violet recorder thus enabling a more detailed examination of the original recording if a section of the results were atypical or seemed suspect, and secondly, the results can be rapidly analysed at a reasonable cost. At the meeting it is proposed to discuss the relative merits of the different methods described in greater detail.

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Some effects of noise on memory and attention

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Working in loud noise (in excess of 90dB(A)) is stressful, particularly when the task being performed is a demanding one. In order to maintain high levels of efficiency under stressful conditions, one strategy that may be adopted is to attend selectively to those aspects of the task situation that are considered important and to those task events which are considered most likely to occur. In this way the task situation is made less demanding. Recent evidence concerning the effects of noise on tasks involving memory and attention is reviewed and a comparison is made between the effects of noise and other stresses which seem to have similar effects. Some experiments are also described.