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Unification of Noise Criteria
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The Application of Noise Criteria

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The problem of deciding which noise criteria can be adopted as the bases of standards is of particular concern to local planning authorities as it is they who would be responsible for their interpretation and application. Such planning authorities, including the Greater London Council are frequently faced with evaluating the effect of motorways and other new roads on the environment, as well as choosing new sites for housing and schools. Among the many factors which have to be taken into account is that of noise, arising from road traffic, aircraft, industry and other public activities. The planning authorities are concerned to attain pleasant and acceptable conditions for their tenants and ratepayers, whilst controlling expenditure closely. Complete noise protection at one site cannot be provided if this is at the expense of some other factor or some particular sections of the community.

For the planner, an objective standard is, therefore, essential which will give a guide to acceptable levels under different conditions of use. There are always two parts to a standard - the criterion by which it is expressed and the numerical value which actually sets the standard.

The main requirements for a criterion which can evaluate community annoyance or disturbance are:-

1. A formula giving reasonably good correlation between noise and annoyance;

2. ease of measurement or calculation;

3. suitability for prediction with a good degree of reliability;

4. equally good application to various sources of noise.

Even at this stage it must be emphasised that any criterion must be based on compromises between the practicable requirements and an academically perfect and accurate formula.

Once the type of unit is established, the criterion level has to be a compromise between social and economic requirements.

In this paper the authors as Scientists working for a local authority propose first to discuss briefly the various formulae which are at present under consideration in this country. These are mainly the Ten Per Cent. Level, Traffic Noise Index, Noise Pollution Level and Noise and Number Index (for aircraft only).

After commenting on acceptable levels, some very tentative proposals are put forward for noise standards, intended to provide a useful discussion after the paper.

Formulae for Noise Evaluation

Whichever formula is used it must be based on a unit which is either measurable or calculable. A great diversity of these units, such as various forms of phons, sones, noyes and decibels with different weightings have been used in the past. Fortunately this situation has now been rationalised and the authors are of the view that only two basic units would be sufficient for most planning and monitoring purposes. These are the A-weighted decibel dB(A), and the Perceived Noise Decibel PNdB, although for noise certification of aircraft a modified unit, Effective Perceived Noise Decibel EPNdB may be desirable.

The dB(A) gives good correlation between sound level and subjective loudness for any single noise occurrence. Where noise fluctuates continuously, as in the case of traffic, the noise can most simply be described as the noise level which is exceeded for a certain percentage of time. The Wilson Committee suggested that the 10% level should be used and their recommendations on adaptable levels are based on this. They tentatively suggested that in busy urban areas inside dwellings a noise level of 50 dB(A) by day and 35 dB(A) by night should not be exceeded for more than 10% of the time. The Wilson standards, as they are now often called have formed the basis of G.L.C. policy since February 1966 when the Council resolved '.... that the recommendation in the report of the Committee on the Problem of Noise (the Wilson Committee) for internal noise levels shall be accepted as desirable standards for all new building schemes;.....'

These standards are based on a large scale social survey carried out at the time of the London Noise Survey. The ten per cent. level is easy to measure, and can be predicted with some accuracy. Unfortunately there appear to be two weaknesses in what after all is the first attempt at suggesting any standards. The more important of these is that there is no attempt at defining day or night. During the day, say, between 7 a.m. and 7 p.m., there is no substantial variation in urban noise level and an average value of day time noise can be used. At night, however, the situation is entirely different - there is a definite pattern in the variation of noise level with a steep drop after about midnight, and an equally steep rise from about 4 or 5 a.m. It is clearly not possible to give any meaningful average for night time noise as this would be entirely dependent on the choice of limits of the night period. - Also an -

extremely low level at, say, 3 a.m. cannot be balanced against a high level at, say, 11 p.m. It seems reasonable to suppose that providing the noise level in the middle of the night is below a certain figure, any further lowering will not provide any additional benefit whereas during the late evening a variation of only a few decibels may be very critical.

The other weakness in the Wilson recommendation is that background levels are not considered, and common sense suggests a high peak level is less disturbing if the background is also high than if it is very low. This factor has been taken into account in the Traffic Noise Index proposed by Scholes and Langdon of the Building Research Station. They found a very good correlation between annoyance and T.N.I. in a survey carried out in dwellings fronting on to busy main roads. The formula, T.N.I. = 4 $(L_{10} - L_{90}) + L_{90} - 30$, when L_{10} and L_{90} are levels exceeded for 10% and 90% of the time respectively, greatly emphasises the difference between L_{10} and L_{90}, i.e., between peak and background levels and is expressed as a single value for a 24 hour period, both L_{10} and L_{90} being averaged over this period.

T.N.I. clearly represents a step in the right direction and its validity in certain situations has been shown in social surveys. There are difficulties which arise in practice and which also suggest that misleading results might be obtained in some situations.

Experience has shown that although L_{10} is readily measured, the position is quite different with L_{90}. In measuring L_{90} errors can easily arise either due to actual instrument noise or due to very local sources of background noise which may affect just a particular point in a road and yet determine the T.N.I. value for a whole stretch of road. This is particularly important at night where a low noise source which may be inaudible by day, may artificially raise the L_{90} level. As T.N.I. depends on the difference between L_{10} and L_{90}, multiplied by 4, any error in L_{90} may cause a serious error in T.N.I. Similarly L_{90} cannot be forecast as one cannot forecast the level due to the multitude of noise sources which make up the background level. The other point is that a single figure cannot represent a 24 hour situation adequately. Although at any particular period a high background level may reduce the annoyance due to a peak, on the present basis an increase in background level at night would reduce the overall T.N.I. and this does not seem reasonable.

The proposal for a Noise Pollution Level put forward by Robinson at N.P.L. has the very great advantage that in its basic form it is applicable to all noise whether from road traffic, aircraft or industry. It is based on a similar concept to T.N.I., but with slightly less emphasis on the background level although this is taken into account in the formula. The basic form of L_{NP} consists of two variables, the equivalent energy level plus a factor dependent on the variability of the noise. The basic formula is not very easy to calculate but a simplified form can be used for assessing a continuously varying

noise providing the absolute range of levels is less than 26 dB(A). Unfortunately the simplified form loses one of the advantages of Noise Pollution Level, as it makes direct comparison with, say, aircraft noise more difficult.

Although in central London our problem is at present mostly concerned with traffic noise, in the western suburbs it is aircraft noise which causes the greatest concern. Assessments of aircraft noise have to be considered from three points of view:- firstly obtaining objective information on whether or not sound insulation is required for existing buildings, particularly schools and colleges, secondly in planning for new residential or educational developments, including deciding whether the development is practicable at all, and thirdly in obtaining facts for use in discussions on aircraft noise with appropriate organisations and authorities. The noise levels are invariably expressed as Perceived Noise Decibels, although in many cases it is considered sufficiently accurate to measure in A-weighted decibels, and to add 13. A precise measurement of PNdB requires an octave analysis followed by a calculation which can be programmed but is still time consuming when measuring a large number of aircraft.

Disturbance due to aircraft is clearly dependent not only on the peak levels but also on the number of aircraft heard. The formula almost exclusively used in this country is the Noise and Number Index which is calculated from the logarithmic average of the peak levels in PNdB, plus 15 times the log of the number of aircraft passing overhead in a given period, usually 6 a.m. to 6 p.m., minus 80.

The method of assessment used in the Scientific Branch is to take A-weighted chart recordings for a specified period of at least 12 hours, but generally for several days and to obtain from these several sets of figures where possible. These are the logarithmic average of the peak levels for day and night, for both landing and departing aircraft, and similarly the N.N.I values for these four conditions. In our calculations we ignore aircraft giving less than 80 PNdB, i.e., 67 dBA) The results of a very large survey carried out by the Board of Trade are now awaited as these will provide a guide on the validity of N.N.I. Until the results are published it is difficult to comment except to say that N.N.I. contours have been used by Surrey County Council as a basis for zoning regulations. Three zones were defined as: Zone 1, over 60 N.N.I. by day (or 45 by night); Zone 2, over 50 by day (35 by night) and Zone3, over 40 by day. In the first zone no development is allowed except hotels with full sound insulation, while in the second zone only infilling of residential developments, again with full sound insulation is permitted. Even in the third zone no major developments are permitted.

Although there may be some criticism of the standards proposed so far, Architects and Planners are daily faced with problems concerning the desirability

and degree of sound insulation required for a particular project and some basis for their decisions is essential.

There are very good arguments for using the Ten Per Cent. Level (L_{10}) as the principal criterion, providing its application is more closely defined. The most critical time when noise is likely to be disturbing in residential areas is neither the middle of the day when the majority of the population is working, nor the middle of the night, when noise levels are generally very low. It is more likely to be the evening period which determines the reaction of people to their environment. This is firstly because they wish to relax, talk or listen to the radio or television during the early part of the evening and secondly because most people desire intruding noise level to be minimal when they are trying to go to sleep. It must be frankly admitted that this opinion is not based on a social survey but purely on an impression which we have gained through experience. It is, therefore, felt that if the Wilson recommendations for night are used they should be applied to the period between 10 p.m. and midnight only, i.e., that 35 dB(A) should not be exceeded for more than ten per cent. of the time during this period. Alternatively assuming that there is a gradual decrease of noise from about 7 p.m. to midnight it is suggested that a desirable standard to be aimed at inside new dwellings is that the average of the levels exceeded for ten per cent. of the time in each of the five one-hourly periods between 7 p.m. and midnight should not exceed 45 dB(A). This level would tend to correspond roughly with the Wilson recommendations but would exclude the period during the night when ten per cent. becomes meaningless due to the noise being caused by isolated events.

Although the recommendations in the Wilson Report have been criticised as being too stringent, they are in fact comparable, or even less demanding than foreign proposals. By planning at the design stage it has been possible to achieve the standards even in situations such as Blackwall Tunnel Northern Approach, where traffic noise levels are very high, without undue extra cost.

For schools and educational establishments generally there appear to be no very definite standards, although the Wilson Report suggested that in buildings where speech communication is important a level of 55 dB(A) should not be exceeded. This is based only on interference with speech, and does not take into account disturbance of concentration and general distraction. The Education Architect of the Inner London Education Authority designs new schools so that 45 dB(A) is not exceeded in classrooms for more than 10% of the time. In the case of existing schools ten per cent. levels of up to 55 dB(A) are considered an acceptable compromise. These figures are subject to revision and at present the Inner London Education Authority and G.L.C. are carrying out a large scale survey to determine acceptable levels in different types of teaching situations.

Noise from industry, although not as widespread as either traffic or aircraft noise, nevertheless causes

serious local problems. Both when existing noise problems arise and when planning applications for industrial undertakings are considered, British Standard 4142:1967 'Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas' has proved a valuable guide. This standard takes background levels and psycho-acoustic factors into account as well as the actual level and type of the intruding noise. There are instances where the standard is inapplicable, and it must be applied with common sense rather than rigidity. On the other hand it has proved to be a useful guide in some instances where it was not even intended to be used, such as noise from public entertainments, and lately even in assessing possible sites for helicopter and VTOL operations.

This paper is presented with the permission of Dr. B. R. Brown, Scientific Adviser to the Greater London Council. The views expressed are those of the authors and not necessarily those of the Council.